

CONTRIBUTIONS

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Contents

	PAGE
No. 43. <i>Choffatella</i> in the Gulf Coastal Regions of the United States and Description of <i>Anchispirocyclina</i> n. gen. Louise Jordan and Esther R. Applin	1
No. 44. Classification of Uniserial Calcareous Foraminifera R. M. Stainforth	6
No. 45. New Names for Northwestern Gulf of Mexico Foraminifera Fred B Phleger and Frances L. Parker	14
No. 46. New Names for Foraminiferal Homonyms Hans E. Thalmann	14
No. 47. Studies on Recent Allogromiidae: 1. <i>Micrometula hyalostriata</i> n. gen., n. sp., from the Gullmar Fjord, Sweden Karl-Georg Nyholm	14
No. 48. The Genotype of <i>Siphogenerina</i> Orville L. Bandy	17
No. 49. Miocene Foraminifera from Erben Bank Orville L. Bandy	18
No. 50. An Occurrence of <i>Miogypsina</i> in California Joseph J. Graham and C. W. Drooger	21
No. 51. <i>Elphidium oregonense</i> Cushman and Grant, a possible marker for Amstelian (Lower Pleistocene) in North America and northwestern Europe J. H. van Voorthuysen	22
No. 52. A trirachiate <i>Flabellinella zitteliana</i> (Egger) from the Upper Cretaceous of Bavaria, with notes on the genus <i>Trirachia</i> Schubert, 1912 Herbert Hagn	24
No. 53. <i>Globigerinoida</i> and <i>Globigerinatheka</i> , new genera from the Tertiary of Trinidad, B.W.I. P. Bronnimann	25
No. 54. Two new species of <i>Lepidocyclina</i> from Cape Range, northwestern Australia Irene Crespin	28
No. 55. Reinstatement of <i>Osangularia</i> Brotzen, 1940, for <i>Parrella</i> Finlay, 1939 (non Ginsburg, 1938) Hans E. Thalmann and Joseph J. Graham	31
Recent Literature on the Foraminifera Ruth Todd	32

WASHINGTON, D. C., U. S. A.

1952

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH

Editor

Hans E. Thalmann

The CONTRIBUTIONS, the official organ of the Cushman Foundation for Foraminiferal Research, publishes original papers on any phase of foraminiferal study and short reviews of recent literature. The CONTRIBUTIONS will be issued quarterly.

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DORR'S PRINT SHOP, BRIDGEWATER, MASSACHUSETTS, U. S. A.

43. CHOFFATELLA IN THE GULF COASTAL REGIONS OF THE UNITED STATES AND DESCRIPTION OF ANCHISPIROCYCLINA N. GEN.¹

LOUISE JORDAN
Youngstown, Ohio

and

ESTHER R. APPLIN
U. S. Geological Survey, Jackson, Miss.

Abundant specimens of the foraminiferal genus *Choffatella* were found in cores taken between the depths of 10,020 and 10,070 feet, in beds of Trinity (Early Cretaceous) age, in Coastal Petroleum Company's E. C. Wright well No. 1 (sec. 7, T. 30 S., R. 17 E.), Pinellas County, Florida. The well was abandoned July 2, 1948, at a total depth of 11,507 feet. Prior to the identification of *Choffatella* in the Wright well, occasional fossil sections had suggested the occurrence of this genus in several wells in south Florida that penetrated the largely nonclastic facies of Lower Cretaceous rocks. The cores from the Wright well, however, yielded the first and the largest collection of free specimens that were adequate for critical study.

The discovery of *Choffatella* in Florida suggested to the writers that an investigation of occurrences of this genus reported from other localities in the United States would be welcomed by geologists, since they use fossils as a major factor in the regional correlation of stratigraphic units. The relatively narrow stratigraphic range and world-wide geographic distribution of *Choffatella decipiens* Schlumberger (Maync, 1949, pp. 533-35) should enhance the value of the species for the purpose of correlation.

Reports of other writers who have referred to the occurrence of the genus *Choffatella* in the United States are here summarized. Adkins (1933, p. 333) included *Choffatella aff. C. decipiens* Schlumberger in a list of the Foraminifera found in samples taken from an outcrop of the Walnut Clay (Fredericksburg group, Comanche series) on Mount Barker, Travis County, Texas. Swain (1947, p. 2059) reported that L. G. Henbest identified as, "related to *Choffatella*," specimens of Foraminifera found in a core taken at the depth of 9115 to 9116 feet in Standard Oil Company's (New Jersey) Cape Hatteras Light well No. 1 (N. C. Esso No. 1), Dare County, North Carolina. Jordan and Applin (1949, p. 1636) presented a preliminary report on the occurrence of the genus *Choffatella* in wells in south Florida at the American Association of

Petroleum Geologists Regional Meeting, Biloxi, Mississippi, Oct. 12-14, 1949. Maync (1949, p. 533) identified *Choffatella decipiens* Schlumberger from cores of Wright well No. 1, Pinellas County, Florida. Lozo (1949, p. 89) recorded *Choffatella* (?) from subsurface sections of the "Walnut formation" in Williamson County, Texas.

Unpublished data on the possible occurrence of *Choffatella* in two other areas were kindly furnished by Frank E. Lozo.² In connection with outcrops in which forms referred to the genus were found, Lozo stated, "The species identified by Helen Jeanne Plummer from the 'Walnut Clay' of the Travis County, Texas, area also occurs in the Glen Rose of Comal County. It is common in Professor (F. L.) Whitney's, 'Solenites texana zone' just beneath the 'Corbula bed,' which is 'approximately 440 feet below the top of the 740-foot Comal County Glen Rose section.' Lozo pointed out that the species is also common about 520 feet below the top of the Comal County section, where it is associated with abundant specimens of *Orbitolina whitneyi*.

Lozo's subsurface studies in northern Louisiana suggested the presence of *Choffatella* in that area. He recognized a faunal zone in the Sligo formation (Lower Cretaceous) containing specimens of a foraminiferal genus which he tentatively identified as "*Cyclammina*," but he suggested the possibility that it belonged, in fact, to the genus *Choffatella*.

In connection with the preparation of this report the writers studied specimens of lituolid Foraminifera from all but one of the localities mentioned in the preceding paragraphs. The form from the Wright well No. 1, Pinellas County, Florida, is herein described as *Choffatella decipiens* Schlumberger; specimens from the subsurface Sligo formation of Louisiana are also assigned to that genus and species. In an earlier publication Applin, Loeblich, and Tappan (1950) described as two new genera and species the lituolid Foraminifera found in the outcrop of the Walnut Clay on Mount Barker, Travis County, Texas, and in outcrops of the Glen Rose limestone, Comal County, Texas. These forms

1. Publication authorized by the director of the United States Geological Survey.

2. Letter to Louise Jordan, dated Sept. 13, 1948.

were named *Stomatostoecha plummerae* (Pl. 1, figs. 1, 2.) and *Phenacophragma assurgens*. In the present report the writers have erected a new genus and species, *Anchispirocyclina henbesti*, to define the form discovered in the Cape Hatteras Light well No. 1, Dare County, North Carolina. Specimens of the "*Choffatella* (?)," reported from subsurface sections in Williamson County, Texas, were not available.

A thickness of approximately 740 feet of Glen Rose limestone is exposed on the Byler Ranch in Comal County, Texas (George, 1947, pp. 20-21). Samples collected from this locality by geologists under the direction of F. W. Rolshausen, Humble Oil and Refining Company, were studied by E. R. Applin. Samples taken at the base of the section and at irregular intervals between the base and a point 300 feet above the base contained specimens of an undescribed species of *Coskinolina* associated with many specimens of *Orbitolina texana* Roemer. In wells in south Florida the same species of *Coskinolina* accompanied by *Orbitolina texana* occur in samples taken in the "Sunniland" limestone, the producing zone of the Sunniland field, Collier County, Florida. Specimens of *Choffatella* were not found in the samples from the Byler Ranch locality, but in wells in south Florida *Choffatella decipiens* Schlumberger accompanied by specimens of *Orbitolina texana* Roemer occur below a zone of "thick anhydrite," which in turn underlies the "Sunniland" limestone.

Primarily important in the study of *Choffatella* is the determination of the morphological features that characterize the genus and serve to differentiate it from *Cyclammina* and *Pseudocyclammina*. Mayne (1949, p. 536) referred to the "divergent concepts concerning the classification of the Lituolidae." To the writers of this report the "divergent concepts" appear, for the most part, to be the result of the frequently over-simplified and inadequate published generic descriptions of some members of that family. Basic investigations relating to the present study of *Choffatella* included a review of the descriptions and figures of *Cyclammina* and *Pseudocyclammina* in addition to the examination of specimens and sections of these forms. The material relating to *Cyclammina* and *Pseudocyclammina* was compared with published descriptions and figures of *Choffatella decipiens* Schlumberger and with specimens and sections of the *Choffatella* found in the Wright well No. 1. The taxonomic conclusions given herein are based on these investigations.

The unrestricted use of the term "labyrinthic" in connection with the description of certain internal features of *Cyclammina*, *Pseudocyclammina*, and *Choffatella* is possibly the major source of confusion in the differentiation of these genera. Increasing precise and detailed descriptions of the internal characters, particularly the wall structures, are of vital importance. The type of aperture is another significant feature; and in

addition the shape of the chambers may prove to have generic value. Differing from the authors of the genus *Pseudocyclammina*, the writers of this report regard as of secondary importance the tendency of that form to become evolute in its final growth stages. A similar tendency was observed on some specimens of *Choffatella decipiens* Schlumberger obtained from wells in Florida.

The wall structure of each of these genera *Choffatella*, *Cyclammina*, and *Pseudocyclammina* has a thin, imperforate surface layer and a subepidermal cellular layer, but the subepidermal layer shows distinct differences in character and origin on each of the forms discussed. In *Choffatella* this feature was clearly described by Schlumberger (1904, p. 763) as, "réseau très serré de mailles circulaires." This alveolar layer is composed of thin, parallel and subtransverse partitions that form a shallow reticulate pattern similar to but less regular than that found in the subepidermal layer in the *Orbitolinidae*. Schlumberger further discusses this feature and its relationship to the underlying septal wall by stating that the walls are crossed by a line of many canals, on both sides of which small projections anastomose toward the surface of the test and form on it an elegant network of circular openings—the subepidermal layer. In *Choffatella* the septal walls are thin, and the intraseptal canals are fine and are evenly and regularly spaced. The thick peripheral and septal walls in *Pseudocyclammina* are composed of a relatively coarse and irregular series of arenaceous plates that occasionally coalesce. The canals between the plates are correspondingly irregular. The subepidermal, cellular layer is coarser and more irregular than that present in *Choffatella*, and is formed of the outer termini of the plates and canals composing the inner portion of the wall structure. The chamber space in both *Choffatella* and *Pseudocyclammina* is unfilled. In *Cyclammina*, the peripheral portion of each chamber, the thick chamber walls, and, in some species, the entire chamber area are made up of an arenaceous, osculating, tubular growth. The subepidermal, cellular layer in this genus represents the exterior portion of the labyrinthic interior communications.

The aperture in *Cyclammina* is a curved opening at the base of the terminal chamber, often supplemented by several large pores on the septal face. In *Pseudocyclammina* the aperture is cibrate, whereas in *Choffatella* a series of fine pores extends in a linear series down the central portion of the narrow, apertural face.

In *Choffatella* the chambers are long, narrow, and strongly arched. In *Cyclammina* and *Pseudocyclammina* they are relatively broad and narrowly V-shaped in outline.

In its early growth stages *Pseudocyclammina* is involute but in later stages it may become evolute, a tendency not confined to this genus, as pointed out in an earlier paragraph in this paper.

DESCRIPTIONS

Family LITUOLIDAE

Subfamily LITUOLINAE

Genus *Choffatella* Schlumberger, 1904*Choffatella decipiens* Schlumberger

Plate 1, figures 3-8

Plate 2, figures 5-10

Choffatella decipiens SCHLUMBERGER, Schlumberger, 1904, Bull. Geol. Soc. France, Ser. 4, vol. 4, p. 763, pl. 18, figs. 1-6.

Choffatella decipiens SCHLUMBERGER, Tobler, 1928, Ecl. Geol. Helv. vol. 21, no. 1, p. 212 ff. pl. 24, figs. 4-6.

Choffatella decipiens SCHLUMBERGER, Silvestri, 1942, Real Accad. d'Italia, Estr. da Miss. Geol. nella Dancalia Merid. e nel Hararino promosa dall' A. G. I. P. vol. 2, pp. 4-6, pl. 2, fig. 1.

Choffatella decipiens SCHLUMBERGER, Henson, 1948, pp. 14-15, pl. 9, fig. 1.

Choffatella decipiens SCHLUMBERGER, Maync, 1949, Ecol. Geol. Helv., vol. 42, no. 2, pp. 529-547, pls. 11-12.

Discussion.—A detailed study of the specimens of *Choffatella* found in the Wright well No. 1 convinced the writers that the Florida species was, in fact, *Choffatella decipiens* Schlumberger. It seemed desirable, however, to compare the Florida forms with the genotype, deposited in the Sorbonne, in Paris. Accordingly, specimens of *Choffatella* from the No. 1 Wright well were sent to Mme. Y. Gubler (Institut Francais du Petrole, Laboratoires de Sedimentation), who had kindly offered to make a comparison with the genotype and topotypes. The following report was received from M. Neumann:³ "Madame Gubler m'a confié les échantillons de *Choffatella* que vous lui aviez expédiés pour être étudiés. J'en ai fait des sections et je crois pouvoir affirmer, après comparaison avec les types de Schlumberger, que ce sont des *Choffatella decipiens*."

From specimens requested from the writers, Maync (1949 p. 533) also confirmed the determination of the *Choffatella* from Florida as *Choffatella decipiens* Schlumberger.

In addition to the abundant specimens in the Wright well No. 1, sections of *Choffatella decipiens* occurred in cores in seven wells in south Florida. The wells are O. D. Robinson's State of Florida well No. 1 (sec. 29, T. 59 S., R. 40 E.), Monroe County; and the following six wells drilled by the Humble Oil and Refining Company: G. C. Carlton Estate well No. 1 (sec. 34, T. 38 S., R. 29 E.), Highlands County; Tucson Corporation well No. 1 (sec. 35, T. 43 S., R. 40 E.), Palm Beach County; B. T. Keen well No. 1 (sec. 23, T. 35 S., R. 23 E.), Hardee County; Gulf Coast Realties Corporation well No. 2 (sec. 30, T. 48 S., R. 30 E.), Collier

County; Lowndes-Treadwell well No. 1 A (sec. 17, T. 42 S., R. 23 E.), Charlotte County; T. S. Jameson well No. 1 (sec. 7, T. 31 S., R. 22 E.), Hillsborough County.

The species is observed most frequently in an oolitic limestone, but in the Wright well No. 1, and occasionally in other wells, specimens were found in dark-gray marly shales and shaly limestones. The samples from the Sligo formation of Louisiana were also from dark-gray calcareous shales. *Orbitolina* usually accompanies the *Choffatella* in Florida as a common constituent of the microfauna. Several species of miliolid Foraminifera are generally abundant, and some specimens of *Pseudocyammina lituus* (Yokoyama) and *Lituola* sp. may also be present. Shallow water, marine depositional conditions are indicated.

Dr. F. E. Lozo very kindly sent us some material and specimens of his "Cyclammina," taken from a core at 5550 to 5555 feet in the Prairie River Syndicate Hutchinson well No. 1 (sec. 15, T. 15 N. R. 12 W.), Caddo Parish, Louisiana. Most of the fossils were smaller than the average Florida specimens, but in structural details conformed to the requirements of *Choffatella decipiens* Schlumberger. In his letter Dr. Lozo states, "I have recognized this 'Cyclammina-Verneuilina' zone in Webster, Bossier, and Caddo parishes, Louisiana" . . . it "occurs in the Sligo formation of Louisiana, never, however, in association with *Orbitolina*."

In Florida, *Choffatella decipiens* Schlumberger occurs in beds of Trinity (Early Cretaceous) age, whereas Lozo's zone is in the Sligo formation (Early Cretaceous) in the subsurface of northern Louisiana. The European equivalents for these stratigraphic units, as given by Imlay (1945, p. 1418) are Lower Aptian and Lower and Middle Albian.

In view of the discovery of *Choffatella decipiens* Schlumberger in parts of the United States as widely separated as northern Louisiana and peninsular Florida, it seems reasonable to suggest that this species may in the future be found in other portions of the Gulf Coastal region, where subsurface sections of similar marine Lower Cretaceous deposits are developed.

Plesiotypes (U.S.N.M. nos. P. 803-804) from core, 10,045 to 10,050 feet, in Coastal Petroleum Company's E. C. Wright well No. 1, Pinellas County, Florida.

Plesiotype (U.S.N.M. no. P. 814) from core 5550 to 5555 feet in Prairie River's Hutchinson well No. 1, Caddo Parish, Louisiana.

Anchispirocyclina, n. gen.

Genotype *Anchispirocyclina henbesti* Jordan
and Applin, n. sp.

Description.—Test free, compressed, planispiral, almost completely involute; walls calcaro-arenaceous, surface imperforate; chambers numerous, narrow elongate; septa arcuate. A thin subepidermal layer pres-

3. Letter to Louise Jordan, dated Feb. 13, 1950.

ent, closely similar to that present in *Choffatella*. Below this superficial layer the chamber walls are composed of a regular, closely and evenly spaced series of lamelliform buttresses that align from one chamber to the next. These buttresses partly fill the chamber area but leave a narrow canal that borders the preceding septal wall. Equatorial sections seem to show a labyrinthic type of structure occupying the central, or innermost, portion of the test. This is apparently formed from the gradual inward elongation and ramification of the buttresses present in the immediately overlying structural feature, described above. Aperture broken and indistinct on all free specimens studied.

Remarks.—Unfortunately, no oriented thin sections of the new genus were obtained. Only a few young specimens were successfully removed from the matrix, and though the specimens were very abundant the tests were usually somewhat worn and broken and were deposited at various angles in a moderately hard, gray sandy limestone. However, L. G. Henbest kindly contributed 79 thin sections of the material that contained numerous sections of the fossil. Our studies of these sections revealed consistent repetitions of the morphological feature described and seem to substantiate our conclusions.

As the description indicates, *Anchispirocyclina* is taxonomically close to *Spirocyclina*, but no annular or reniform growth stages were found on any mature specimens of our genus.

Anchispirocyclina henbesti Jordan and Applin, n. sp.

Plate 2, figures 1-4

Plate 3, figures 1-3

Description.—Test free, planispiral, compressed, generally ellipsoidal in outline; periphery entire, subacute; surface smooth, imperforate, composed of microgranular calcareous particles with some admixture of fine quartz grains; three whorls on mature forms, opening

rapidly, the final convolution greatly expanded, especially on microspheric specimens; plane of coiling slightly fluctuating; chambers numerous, narrow and elongate, strongly curvilinear, 25 usually present in the final whorl of microspheric forms, an average of 18 on megalospheric specimens. Internal structure of the test showing three layers, or stages: (1) a thin, subepidermal cellular layer, composed of fine, intersecting partitions that form a delicate, reticulate pattern, similar to that present in the Orbitolinidae but less regular; (2) below this superficial structure, the chamber walls are composed of a linear series of lamelliform buttresses separated by narrow, intraseptal canals. The buttresses align from one septum to the next, and partly fill the chamber area, leaving a narrow, open passage that borders the preceding chamber wall; (3) central, or innermost, portion of the test occupied by a labyrinthic type of structure that probably represents the spreading and anastomosing inward projections of the buttresses seen in the second layer. This feature retains some structural regularities, and could be more precisely described as "semilabyrinthic" or by the term "nonlabyrinthic" as defined by Maync (1949, p. 536). Some sand grains are incorporated in this third layer, and a few are seen in other interior portions of the test. Details of the internal features just described are shown on the highly magnified figure (Pl. 2, fig. 4). Average greatest diameter of microspheric specimens — 4.4 mm. Average greatest diameter of megalospheric specimens — 1.5 mm. Average diameter of initial chamber of megalospheric specimens — 0.15 mm.

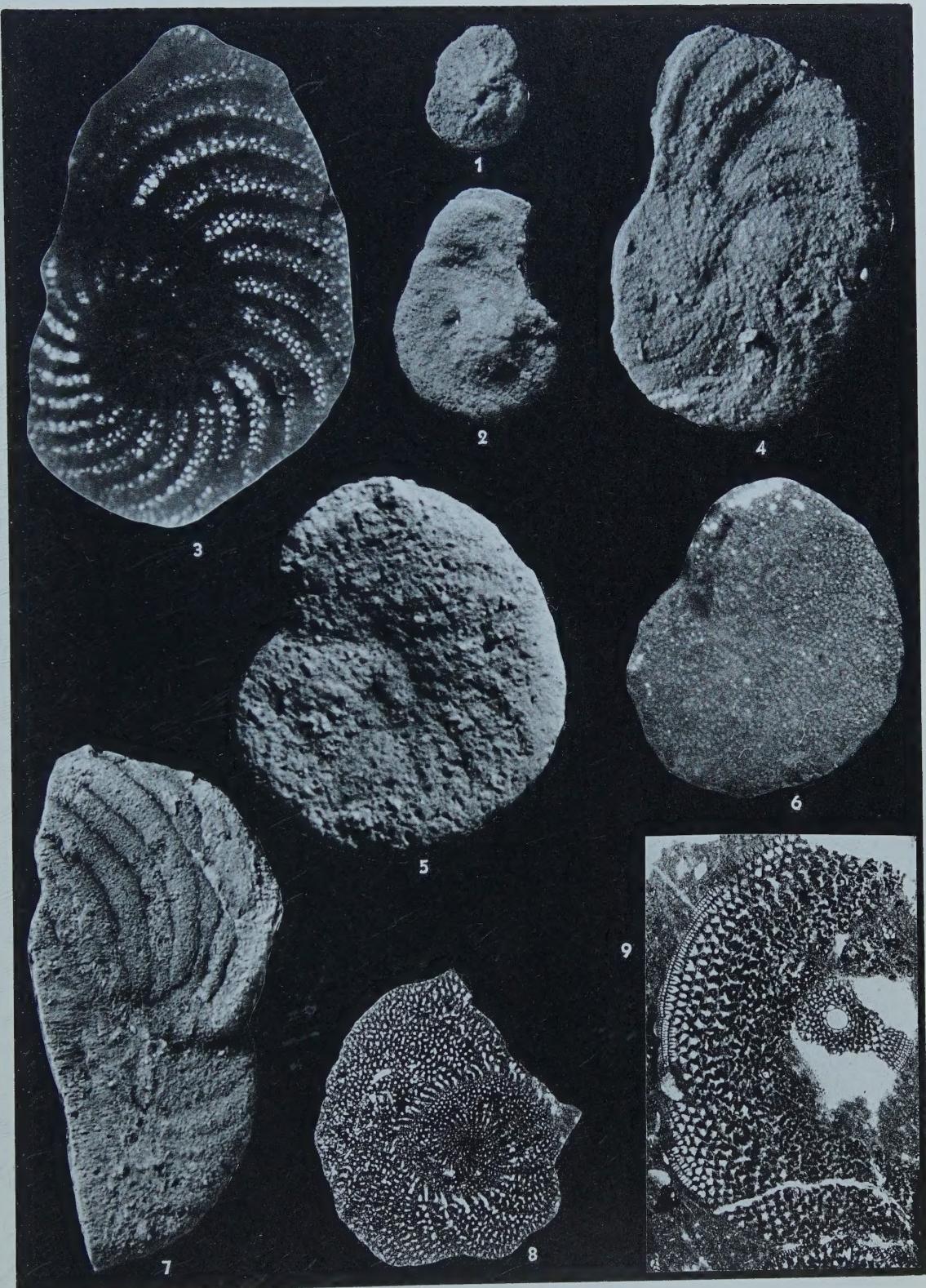
Stratigraphic position.—Swain (1947, p. 2059) placed the interval, 8,500 to 9,150 feet in the Esso well, "tentatively in the Lower Cretaceous." Later⁴ he stated, "The ostracodes from the depths 8,500 to 9,210 feet are Upper Jurassic rather than Cretaceous as I once thought." In regard to the core sample that yielded

4. Letter to E. R. Applin, dated Jan. 10, 1950.

EXPLANATION OF PLATE 1

FIGS.

FIGS.		PAGE
1-2.	<i>Stomatostoecha plummerae</i> Applin, Loeblich and Tappan, Exterior views of Heautotypes shown for comparison with <i>Choffatella</i> . Both from the Walnut Clay, just below the <i>Dictyoconus walnutensis</i> (Carsey) ledge on the south side of Mount Barker, Travis County, Texas. $\times 30$.	2
3.	<i>Choffatella decipiens</i> Schlumberger, Plesiotype, megalospheric specimen, polished to center of equatorial section on one side and photographed by transmitted light. From core, 10,045 to 10,050 feet in Coastal Petroleum Company's E. C. Wright well no. 1, Pinellas County, Florida. $\times 50$.	3
4, 6.	<i>Choffatella decipiens</i> Schlumberger, Plesiotypes. Exterior views of megalospheric specimens. Fig. 6 illustrates pyritised reticulate subepidermal layer. Locality same as above. $\times 40$.	3
5.	<i>Choffatella decipiens</i> Schlumberger, Plesiotype, Exterior view of specimen from core, 5550 to 5555 feet in the Prairie River Syndicate, Hutchinson well no. 1, Caddo Parish, Louisiana. $\times 48$.	3
7.	<i>Choffatella decipiens</i> Schlumberger, Plesiotype. Broken microspheric specimen, from core, 1045 to 1050 feet in the Coastal Petroleum Company's E. C. Wright well no. 1, Pinellas County, Florida. $\times 30$.	3
8.	<i>Choffatella decipiens</i> Schlumberger, Plesiotype. Shallow section of megalospheric specimen, within the subepidermal layer, parallel to the equatorial plane. Locality same as for fig. 7. $\times 30$.	3
9.	<i>Orbitolina</i> ex. gr. <i>concava texana</i> Roemer. Associated with <i>Choffatella decipiens</i> . Locality same as for fig. 8. $\times 20$.	3

Jordan and Applin: *Choffatella* and *Anchispirocyclina*



Jordan and Applin: *Choffatella* and *Anchispirocyclina*

the *Anchispirocyclina henbesti* described, he writes,⁵ "I think that horizon is Portlandian and probably corresponds to the Shuler formation of Louisiana." In addition to abundant specimens of the new genus, the samples studied by the writers contained only a few specimens of *Vaginulina* sp., *Robulus* ? sp., and some fragments of macrofossils. It is therefore impossible for the authors to present any additional evidence regarding the age of the formation in which *Anchispirocyclina henbesti* was discovered.

The species is named in honor of L. G. Henbest, U.S.G.S. Holotype — (figured) — U.S.N.M. no. P. 816. Paratypes figured nos. P. 817-821, from core 9115 to 9116 feet in the Standard Oil Company's (New Jersey) Cape Hatteras Light well No. 1 (N. C. Esso No. 1), Dare County, North Carolina.

Paratype (unfigured) U.S.N.M. nos. P. 822a-c, locality same as above.

Acknowledgments.—We wish to acknowledge indebtedness to L. G. Henbest, U. S. Geological Survey, Washington, D. C., who generously contributed the thin sections that formed the basis of our studies on *Anchispirocyclina*, and made many helpful suggestions; to Frank E. Lozo, Shell Oil Company, Houston, Texas, who gave us information regarding the Louisiana occurrences of *Choffatella* and furnished material from that area; to N. Neumann, Paris, France, for comparing Florida specimens of *Choffatella decipiens* Schlumberger with types of the species; to H. G. Naegeli, Florida State Geological Survey, Tallahassee for his assistance in translating many foreign articles; to Robert O. Vernon and James L. Calver, Florida State Geological Survey, Tallahassee, and Eleanor T. Caldwell, Humble Oil and Refining Company, Tallahassee, for their valued criticisms and help in many ways, which furthered the progress of this paper.

5. Ibid.

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EXPLANATION OF PLATE 2

FIGS.	PAGE
1-2. <i>Anchispirocyclina henbesti</i> Jordan and Applin, n. gen., n. sp. Paratypes. Sections of megalospheric specimens, from core, 9115 to 9116 feet in Standard Oil Company's, (New Jersey) Cape Hatteras Light well no. 1, (N. C. Esso no. 1) Dare County, North Carolina. $\times 30$.	4
3. <i>Anchispirocyclina henbesti</i> Jordan and Applin, n. gen., n. sp. Holotype. Section of microspheric specimen. Locality same as above. $\times 30$.	4
4. <i>Anchispirocyclina henbesti</i> Jordan and Applin, n. gen., n. sp. Highly magnified portion of holotype showing internal structural details. $\times 100$.	4
5-8. <i>Choffatella decipiens</i> Schlumberger, Plesiotypes. Figs. 5, 6, axial sections; figs. 7, 8, equatorial sections of megalospheric specimens. All from core, 10,045 to 10,050 feet in Coastal petroleum Company's E. C. Wright well no. 1, Pinellas County, Florida. $\times 30$.	3
9. <i>Choffatella decipiens</i> Schlumberger, Plesiotype. Broken specimen showing exterior. Locality same as for figs. 5-8. $\times 30$.	3
10. <i>Choffatella decipiens</i> Schlumberger, Plesiotype. Equatorial section. From core, 5550 to 5555 feet in the Prairie River Syndicate, Hutchinson well no. 1, Caddo Parish, Louisiana. $\times 50$.	3

Photographs 1-3 and 5-10 by N. W. Shupe, U. S. Geological Survey.
Photograph 4 by L. G. Henbest, U. S. Geological Survey.

44. CLASSIFICATION OF UNISERIAL CALCAREOUS FORAMINIFERA

R. M. STAINFORTH

International Petroleum Company, Talara, Peru

ABSTRACT—Attention is drawn to confusion in the nomenclature of uniserial calcareous Foraminifera with non-radiate apertures. The main points raised are: (1) **Nodosarella** is a prior synonym of **Ellipsonodosaria**, which latter name is, therefore, invalid and should be rejected. By definition **Nodosarella** is a uniserial form and the name should not be applied to species with a biserial initial portion. The correct name for such species appears to be **Ellipsoidella**. (2) **Siphonodosaria** is a prior synonym of **Nodogenerina**, which latter should, therefore, be rejected. (3) Certain species described under **Nodogenerina** are not congeneric with the genotype [**Siphonodosaria bradyi** (Cushman)]. A new genus **Orthomorphina** is proposed for these species with **Nodogenerina havanensis** Cushman and Bermudez as genotype. (4) The habitual reference of species with an internally-toothed, siphonate aperture to **Ellipsonodosaria** is faulty. They should be placed in **Siphonodosaria**. (5) The neglected name **Lagenonodosaria** appears valid for certain species which differ from the genera mentioned above.

At present authors are not unanimous in their treatment of the uniserial calcareous foraminifera with non-radiate apertures. Many follow Cushman's classification¹ uncritically, but others recognize its faults and use a modified system. The present writer's attention was drawn to the question by a study of the correct nomenclature of numerous siphonate species which Cushman and collaborators have persistently referred to "*Ellipsonodosaria*" although they lack the diagnostic features of *Ellipsonodosaria* A. Silvestri 1924. Various authors have made casual reference to the problem while discussing individual species, and more general notes have been offered by Jedlitschka² and Glaessner³. There seems, however, to be no formal summary of the taxonomy of these nodosarian foraminifera and it is therefore believed that publication of the following notes and opinions is justified as a step towards more uniform taxonomic treatment. These notes are, self-evidently, subjective and in no sense authoritative as far as questions of synonymy and priority are concerned.

For assistance in marshalling facts and opinions grateful acknowledgment is made to numerous correspondents, especially to Brooks F. Ellis for supplying obscure references; to Rudolf Grill for examining the status of *Lingulina tuberosa* Gümbel; to C. D. Ovey for re-examining the types of *Siphonodosaria abyssorum* (Brady); to V. Petters for making translations from the Italian of Silvestri; and to Miss Ruth Todd for checking specimens in the Cushman collection.

1. Foraminifera. Their classification and economic use. Harvard University Press, Cambridge, Mass., U.S.A. 1st Ed., 1928; 2nd Ed., 1933; 3rd Ed., 1940; 4th Ed., 1948.
2. Naturf. Ver. Brünn, Verh., bd. 66, pp. 61-71, tfs. 1-3. Brünn (Brno), Czechoslovakia, 1935.
3. Principles of Micropalaeontology, pp. 140, 141. Melbourne Univ. Press, 1945.

Reliance for many type-descriptions and cross-references has been placed on the Ellis and Messina "Catalogue of Foraminifera." The International Petroleum Company is thanked for providing library facilities and permitting publication of this paper.

The uniserial calcareous foraminifera, sometimes termed the nodosarians, can conveniently be divided on the basis of radiate and non-radiate apertures. Genera with radiate apertures are *Nodosaria*, *Dentalina*, *Chrysalogonium* and *Pseudoglandulina*. Since authors are in close agreement as to their distinctive characters no further attention is paid below to these four genera. The confusion which exists affects the genera with non-radiate apertures, and as a basis for further discussion the original designations of *Nodosarella*, *Ellipsonodosaria*, *Ellipsoidella*, *Siphonodosaria*, and *Nodogenerina* are given below:—

Genus *Nodosarella* Rzehak, 1895 *priority*

Type Reference: Naturh. Hofmus., Ann., Bd. 10, p. 219. Vienna, 1895.

Type Species: *Nodosarella tuberosa* (Gümbel) = *Lingulina tuberosa* Gümbel 1868, genotype by subsequent designation of Cushman 1928.

Type Description: (translation) —

"... A crescentic aperture is found among the *Nodosarias* which appear not infrequently in the Cretaceous (*Lingulina rotundata* d'Orb., etc.). These forms, mostly described as *Lingulinas*, differ in their apertures from the true *Lingulinas*, in which the aperture is not crescentic but a rectilinear ("in einer Ebene liegende") silt. A further difference lies in the shape of the shell, in that the nodosarians with a crescentic aperture never possess so broad, compressed and carinate a test as the true *Lingulinas*, but in section appear rounded, at most slightly elliptical (*L. tuberosa* Gümbel). It is worthy of note that, so far as I know, only one definite type of smooth nodosarian exhibits a crescentic aperture, and it would perhaps not be inappropriate to put it in a special subgenus for which I would propose the name *Nodosarella* to separate it from *Nodosaria*..."

Emended description: "Test with the early chambers showing traces of the biserial ancestry but the later ones in a rectilinear series, very slightly involute, aperture narrow, semicircular." (Cushman, Contr. Cushman Lab., vol. 3, p. 72, 1927).

Genus *Ellipsonodosaria* A. Silvestri, 1900 *X*

Type Reference: Accad. Sci. Lettere Arti Acireale, Q. Sci., Atti Rend., Acireale, Sicilia, Italia, 1900 n. s., vol. 10, mem. 5, p. 3.

Type Species: *Ellipsonodosaria rotundata* (d'Orb.) = *Lingulina rotundata* d'Orbigny 1846.

Type Description: (translation) —

"These are the *Nodosariae* of uncertain position, re-

ferred to by some as belonging to *Lingulina*, by others to *Nodosaria*, and represented by *Lingulina rotundata* d'Orbigny. On account of their special origin I should be inclined to distinguish them as "Ellipsonodosariae." They may be easily distinguished by the arcuate and not round form of their aperture." (NOTE: Silvestri follows this paragraph with general comments on the Ellipsoidinidae and mentions absence of internal tubes in *Ellipsonodosaria*).

Genus *Ellipsoidella* Heron-Allen and Earland, 1910

Type reference: Roy. Micr. Soc., Jour., pp. 410, 414, London, 1910.

Type species: *Ellipsoidella pleurostomelloides* Heron-Allen and Earland 1910.

Type Description: —

"Test free, cylindrical, the early chambers somewhat compressed and arranged in an irregularly triserial or biserial manner, the later chambers nodosarian; aperture a terminal crescentic slit, surmounted by a slightly raised and overhanging process. The interior of each chamber traversed from base to apex by a column similar in appearance, position and structure to the internal column of *Ellipsoidina*."

Genus *Siphonodosaria* A. Silvestri, 1924

Type Reference: Soc. Geol. Ital., Boll., Rome, 1924, Vol. 42 (1923), p. 18.

Type Species: Not designated. By subsequent designation *Siphonodosaria abyssorum* (Brady) = *Nodosaria abyssorum* Brady 1881, first species included in the genus, in Cushman, Contr. Cushman Lab., vol. 3, p. 69, pl. 14, fig. 20. 1927.

Type Description: (translation) —

"This is a new generic name which I propose today for those *Nodosariae* which originate from the *Siphogenerinae* and may be considered as representing the highest stage of evolution."

Genus *Nodogenerina* Cushman, 1927

Type Reference: Contr. Cushman Lab. Foram. Res., vol. 2, p. 79. 1927.

Type species: *Nodogenerina bradyi* Cushman 1927 = *Sagrina virgula* Brady 1884 in part.

Type Description: —

Test uniserial, straight, chambers increasing in size as added, distinct, inflated, constricted at the connection between chambers; wall calcareous, finely perforate; aperture terminal, central, rounded, with a cylindrical neck and phialine lip. The genus . . . is a derivative as an end form from *Siphogenerina*.

By definition *Nodosarella* Rzehak 1895 and *Ellipsonodosaria* Silvestri 1900 appear to be synonymous. Rzehak indicated that *Lingulina rotundata* d'Orb. was a representative species of *Nodosarella*, yet Silvestri chose this same species as genotype for *Ellipsonodosaria*. This synonymy has been pointed out by Nuttall⁴ and Glaessner⁵, and is accepted without discussion in

4. Jour. Pal., vol. 6, p. 23, 1932.

5. Loc. cit., p. 141.

recent papers by Bermudez⁶, but most authors have followed Cushman (see above) in his emended description of *Nodosarella* as a genus with traces of its biserial ancestry.

Rigid application of the rules of nomenclature appears to call for three steps in rectifying the confusion, viz.

- (i) The name *Ellipsonodosaria* should be rejected completely. Species named *Ellipsonodosaria* in accordance with Silvestri's definition should be transferred to *Nodosarella*.
- (ii) The name *Nodosarella* should be applied only to uniserial species and not to species showing biseriality of the initial portion.
- (iii) A new name should be proposed, or an old one revived, for the species which show biseriality. These forms intermediate between *Pleurostomella* and *Nodosarella* are exactly covered by the definition of *Ellipsoidella* (see above), and it seems that this genus should be restored to general use. It has been suppressed in the Cushman classification as a synonym of *Nodosarella* Cushman (non Rzehak) but this procedure now appears unjustified.

(In practice some difficulty exists in separating marginal species of the two closely related genera *Nodosarella* and *Ellipsoidella*. For this reason some thought was given to the possibility of changing the rank of *Ellipsoidella* to a subgenus of *Nodosarella*. This idea was not adopted, however, as there is little precedent for such action and it has not been considered necessary in comparable cases in other closely-knit foraminiferal families, e. g. *Plectofrondicularia* and *Amphimorphina*, *Valvulinaria* and *Discorbis*, *Virgulina* and *Bolvina*, and many others).

No difference is readily apparent between *Siphonodosaria* Silvestri 1924 and *Nodogenerina* Cushman 1927. Both authors evidently visualized an attenuated development from *Siphogenerina*, and there is nothing in Cushman's description of *Nodogenerina* which is not implicit in Silvestri's regrettably brief definition of *Siphonodosaria*. In probably the first reference in English to *Siphonodosaria*, Cushman (see genotype designation above) described it as "uniserial, chambers generally globular, with a neck and phialine lip and large rounded aperture," a description not significantly different from that of *Nodogenerina*. Glaessner⁶ has later introduced the presence or absence of an internal tooth as a diagnostic feature, but no foundation for this is seen in the literature.

The genotypes of *Siphonodosaria* and *Nodogenerina* belong to widely distributed species-groups which authors have tended to treat as congeneric (currently

6. Cushman Lab., Spec. Publ., no. 25, pp. 231, 232. 1949.

7. Soc. Ital. Sci. Nat. Milano, Atti, vol. 62, fasc. 3-4, p. 347, pl. 7, figs. 58-60; p. 348, tf. 28. Milan, 1924.

8. Loc. cit., p. 140.

usually under the name *Ellipsonodosaria*). A characteristic of all these species is the existence of microspheric and megalospheric forms, the former with a set of tapering initial chambers, the latter with a large bulbous initial chamber, but both identical as to adult chambers and aperture (see Text Fig. 1, e, f). The fact that Cushman, in the plates for his well-known textbooks, has figured the microspheric form for *Nodogenerina* but the megalospheric form for *Siphonodosaria* has possibly introduced a conceptual difference between these genera which has no basis in fact.

The present writer is of the opinion that *Siphonodosaria* and *Nodogenerina* are synonymous, in which case the prior name *Siphonodosaria* should be retained, *Nodogenerina* being rejected.

This procedure introduces the question of which foraminiferal family should include the genus *Siphonodosaria*, since in Cushman's classification *Siphonodosaria* falls in the Buliminidae whereas the apparently synonymous *Nodogenerina* is placed in the Heterohelicidae. There seems very little doubt that *Siphonodosaria* is a Buliminid genus. Silvestri's stated concept, at first maintained by Cushman (for *Nodogenerina*) was a genus phylogenetically one stage further evolved than *Siphogenerina*. Later Cushman erected a subfamily Eouvigerininae of the Heterohelicidae with the lineage *Heterohelix-Eouvigerina-Pseudouvigerina-Siphogenerinoides-Nodogenerina*, a parallel to the Buliminid subfamily Uvigerininae. This classification is faulty, as shown by Stone's conclusive demonstration that *Siphogenerinoides* belongs to the Buliminidae⁹.

On the foregoing grounds *Siphonodosaria*, including *Nodogenerina*, is placed in the Buliminidae, but there are certain Nodosarians which may well have evolved from the Heterohelicidae. Several such species have been described under *Nodogenerina* though not conforming with Cushman's designation of that genus. It seems necessary to erect a new genus to receive these forms, viz.

Order FORAMINIFERA

Family HETEROHELICIDAE (?)

Subfamily PLECTOFRONDICULARIINAE (?)

Genus Orthomorphina gen. nov.

Synonymy: *Nodosaria* (*pars*) of authors

Nodogenerina (*pars*) of authors

Type species: *Orthomorphina havanensis* (Cushman and Bermudez) = *Nodogenerina havanensis* Cushman and Bermudez 1937 (Contr. Cushman Lab., vol. 13, p. 14, pl. 1, figs. 47, 48).

Description: Calcareous, uniserial, straight, thin-shelled, smooth or lightly costate. Chambers usually inflated, sutures distinct. Early chambers usually globular, later chambers tending to become lengthened and apiculate, though in each chamber but the

last the projecting portion is hidden under the next-formed chamber. Chamber arrangement typically slightly irregular, with one or two of the median chambers often larger than the terminal chamber. Usually from five to seven chambers, rarely more than seven. Aperture terminal, central, variously a simple circular orifice as in *O. rohri*, a simple apiculate neck as in *O. obsoleta*, or an apiculate neck with a thickened or everted rim as in *O. havanensis* or *O. challengeriana*. Outline drawings of some typical species are given on Text Fig. 1, t-x.

Species of this genus differ from *Siphonodosaria* in one or more of the following respects: in the usually smaller number of chambers and in the irregularity of their growth; in the apiculate shape of the later chambers and their overlapping arrangement; in the absence of thickened necks or strong constrictions between chambers; in apertural characteristics, especially in the absence of any apertural tooth.

Its suggested systematic position is in the Heterohelicidae, subfamily Plectofrondiculariinae, the end-form of the lineage *Plectofrondicularia-Amphimorphina-Nodomorphina*. This allocation is suggested by the uniserial form, simple terminal aperture, thin shell and light ornamentation. Alternatively its ancestry might be remote, linked with species described under *Dentalina* by Terquem from the European Jurassic (*D. affinis*, *D. alternans*, and numerous others).

Species list: Described species which seems to fall under the new genus *Orthomorphina* include:—

- O. ambigua*** (Neugeboren)
 - = *Nodosaria ambigua* Neugeboren (K. Akad. Wiss.-Math.-Naturw. Cl., Denkschr., Bd. 12, Abt. 2, p. 71, pl. 1, figs. 13-16. Vienna 1856)
- O. challengeriana*** (Thalmann)
 - = *Nodogenerina challengeriana* Thalmann (Eclog. Geol. Helv., vol. 30, p. 341. 1937)
 - = *Nodosaria perversa* Brady (non Schwager) (Challenger Rept., Zool., vol. 9, pl. 64, figs. 25-27. 1884)
- O. contorta*** (Costa)
 - = *Nodosaria contorta* Costa (Accad. Pontiniana Napoli, Atti, vol. 7, fasc. 2, p. 159, pl. 16, fig. 2. 1856)
- (?) ***O. elongata*** (Silvestri)
 - = *Nodosaria scalaris* (Batsch) var. *elongata* A. Silvestri (Accad. Pont. Sci. Nuovi Lincei, Mem., vol. 12, p. 158. 1896)
- O. fijiensis*** (Cushman)
 - = *Siphonodosaria fijiensis* Cushman (Contr. Cushman Lab., vol. 7, p. 30, pl. 4, fig. 10. 1931)
- O. glandigera*** (Schwager)
 - = *Nodosaria glandigera* Schwager (Novara Exped. 1857-59, Geol.-Theil, Bd. 2, Abt. 2, p. 219, pl. 4, fig. 46. Vienna 1866)
- O. havanensis*** (Cushman and Bermudez): genotype, as above.
- (?) ***O. hemiglobosa*** (Degli Innocenti)
 - = *Nodosaria scalaris* (Batsch) var. *hemiglobosa* Degli Innocenti (Accad. Pont. Sci. Nuovi Lincei, Mem., ser. 2, vol. 12, p. 367, fig. 8. 1929)
- O. jedlitschkai*** (Thalmann)
 - = *Nodogenerina jedlitschkai* Thalmann (Eclog. Geol. Helv., vol. 30, p. 341. 1937)

- = *Nodosaria radicula* var. *annulata* Brady (non Terquem et Berthelin, 1875) (Challenger Rept., Zool., vol. 9, pl. 62, figs. 1, 2, 1884)
- (?) *O. laevis* (Cushman and Bermudez)
 - = *Nodogenerina laevis* Cushman and Bermudez (Contr. Cushman Lab., vol. 13, p. 15, pl. 2, fig. 12, 1937)
- O. milletti* (Cushman)
 - = *Nodogenerina milletti* Cushman (Contr. Cushman Lab., vol. 9, pt. 4, p. 86, pl. 8, figs. 17, 18, 1933)
- O. neviani* (Fornasini)
 - = *Nodosaria neviani* Fornasini (R. Accad. Sci. Inst. Bologna, Mem., ser. 4, tomo 10, p. 469, pl. 1, fig. 23, 1890)
- O. obsoleta* (Acosta)
 - = *Nodogenerina obsoleta* Acosta (Torreia, no. 5, p. 5, pl. 1, fig. 8, Havana, Cuba, 1940)
- O. perversa* (Schwager)
 - = *Nodosaria perversa* Schwager (Novara Exped. 1857-59, Geol. Theil, Bd. 2, Abt. 2, p. 212, pl. 5, fig. 29, 1866)
- O. pupoides* (O. Silvestri)
 - = *Nodosaria pupoides* O. Silvestri (Accad. Gioenia Sci. Nat. Catania, Atti, ser. 3, tomo 7, p. 65, pl. 6, figs. 148-158, 1872)
- O. rohri* (Cushman and Stainforth)
 - = *Nodogenerina rohri* Cushman and Stainforth (Cushman Lab., Spec. Publ. 14, p. 39, pl. 5, fig. 26, 1945)
- O. sculpturata* (Cushman)
 - = *Nodogenerina sculpturata* Cushman (Contr. Cushman Lab., vol. 15, pt. 3, p. 63, pl. 10, fig. 55, 1939)

At this point three genera of uniserial calcareous foraminifera with non-radiate apertures have been recognized: *Nodosarella* (including *Ellipsonodosaria*), *Siphonodosaria* (including *Nodogenerina*) and *Orthomorphina* n. gen. These ought to be adequate for a clear-cut classification, but confusion persists because it has become customary to allocate to *Ellipsonodosaria* many species which do not agree with the definition of that genus.

The aperture of *Nodosarella* (formerly *Ellipsonodosaria*) was defined as "arcuata e non rotunda," and Silvestri's intention is well exemplified by the genotype he chose (see Text. Fig. 1, o. p). Other species with this typical Ellipsoidinid aperture were later designated, including *E. chapmani* Silvestri 1923, *E. liebusi* Storm 1929, *E. silesica* Jedlitschka 1930, *E. subnodososa* (Guppy) Nuttall 1928 and *E. torrei* Palmer and Bermudez 1936.

In 1929 Cushman¹⁰ and in 1930 Cushman and Jarvis¹¹ briefly referred certain nodosarians with a toothed tubular aperture to *Ellipsonodosaria*. In 1934 Cushman and Jarvis published a paper entitled "Some interesting new uniserial foraminifera from Trinidad"¹² in which detailed apertural views were given of several forms which have in common a tubular aperture containing a tooth-like process (see Text Fig. 1, i-l). The name *Ellipsonodosaria* was applied to these species and in subsequent literature this lead has been followed in naming many similar forms. Cushman and Jarvis gave

10. Cushman Lab., Contr., vol. 5, p. 96, pl. 14, figs. 1-5.

11. Jour. Pal., vol. 4, p. 364, pl. 33, fig. 12.

12. Cushman Lab., Contr., vol. 10, pp. 71-75, pl. 10.

no formal justification for such a radical expansion of the scope of *Ellipsonodosaria*. Of the rare species *E. dentaliniformis* they remarked (1934, p. 73): "The apertural characteristics of this species are very interesting, showing apparently very close relationships to some of the biserial forms of the Ellipsoidinidae." The basis for this statement is not clear, unless it be the eccentric position of the aperture. Similarity to the hooded aperture of *Pleurostomella* seems slight. Certainly neither this species nor the others figured with it show even a faint apertural resemblance to *Ellipsonodosaria*.

Siphonodosaria suggests itself as the correct genus for these forms with a wide tubular aperture. The species named *Ellipsonodosaria nuttalli* by Cushman and Jarvis had, indeed, been called *Nodosaria abyssorum*, the genotype of *Siphonodosaria*, by earlier authors¹³. However, Cushman and Jarvis (1934, p. 72) opined that "the apertural characteristics of our material seem to be very different from that figured by Brady." This opinion is open to question simply because Brady did not include an end-view in his figures: in side-view (see Text Fig. 1, a, b, d, e) the main difference is in degree of development of the collar, which could be a matter of environment rather than genetics and does not seem an adequate basis for a change of genus. Jedlitschka¹⁴ made detailed studies of *Nodosaria abyssorum* and the closely related *Dentalina verneuili* d'Orb. He referred them to a new genus, *Sagrinnodosaria*, with the covering comment (translation): "They occupy a position intermediate between the genera *Nodosaria* and *Sagrina* but can not be placed directly under either of these, so it seems expedient to me to put both these species together in a single genus for which I propose a name which reveals the intermediate position of the species in question." Jedlitschka made no reference to *Siphonodosaria* in this paper, but it is evident that he had the same idea as Silvestri of a completely uniserial development from *Siphogenerina* and he specifically included *N. abyssorum*, the genotype of *Siphonodosaria*. In numerous accompanying figures of *S. verneuili* (see Tex. Fig. 1, h, i herewith) Jedlitschka depicts apertural features variable but of the same general type as the Trinidad species figured under *Ellipsonodosaria* by Cushman and Jarvis.

Various authors have evidently been dissatisfied with the allocation of tubular-apertured nodosarians to *Ellipsonodosaria*, as is shown by sundry references of the species *nuttalli*, *verneuili*, *jarvisi*, *lepidula*, etc. to *Siphonodosaria* in the synonymies listed below.

From the foregoing considerations the present writer has formed the opinion that '*Ellipsonodosaria*' *nuttalli*

13. Guppy, Victoria Inst. Trinidad, Proc., vol. 2, p. 12, pl. 1, figs. 10, 11, 1904. Guppy, Geol. Mag., dec. 5, vol. 1, p. 246, pl. 8, figs. 8, 9, 1904. Nuttall, Geol. Soc. Lond., Quart. Journ., vol. 84, p. 81, pl. 5, fig. 2, 1928.

14. Firgenwald, Reichenberg (Liberec), Czechoslovakia, Jahrg. 4, pp. 122-125, 1931.

should be considered congeneric, probably conspecific, with *Siphonodosaria abyssorum* (Brady) and likewise that other nodosarians with a tubular aperture complicated by phialine lips and internal tooth-like processes should be referred to *Siphonodosaria*, never *Ellipsonodosaria*. Proof of the correctness of this opinion clearly rests on an inspection of the apertural details of Brady's types of the species *abyssorum*. With some misgivings as to their availability this problem was set before Mr. C. D. Ovey of the British Museum and he found himself able to reply as follows (private communication): "I have examined Brady's *Nodosaria?* *abyssorum*. The two figured specimens¹⁵ both have apparently siphonate apertures and each has a lip with what appears to be a bifid projection within the mouth of the aperture. Five other specimens are also mentioned but they are all broken. I have six specimens of what Nuttall has identified (in 1926, manuscript list) as *N. abyssorum* from the Naparima beds of Trinidad. These are all broken but are undoubtedly the same as the 'Challenger' forms described and figured by Brady." This positive statement reduces surmise to a minimum. Especially important is the mention of a bifid projection within the aperture of the genotype of *Siphonodosaria* and it can hardly be doubted that if Cushman and Jarvis had known of this they would have referred the species discussed above to *Siphonodosaria* and not to *Ellipsonodosaria*.

The significance of the toothed apertural process in *Siphonodosaria* is a matter for conjecture. It seems rather probable that it is a relic of the internal siphon typical of the Buliminidae, modified — possibly quasi-atrophied — as a result of elongation of the test.

15. Brady. Challenger Rept., vol. 9, pl. 63, figs. 8, 9. 1884.

Samoilova, in describing the species *S. helenae* (see list below), states that the tooth represents lobes diverging radially from the end of the siphon tube. It may be expected that the degree of development of the tooth will vary from species to species. It may even be absent in some forms, but the writer is of the opinion that presence or absence of an apertural tooth should not be given generic significance among the nodosarians which in other respects agree with *Siphonodosaria*. It is considered that the new genus *Orthomorphina* differs in sufficient other aspects that even its species with apertural necks will not be confused with *Siphonodosaria*.

The ancestry of *Siphonodosaria* has usually been regarded as a direct phylogenetic advance from *Siphogenerina*. Cushman has treated *Nodogenerina*, here considered synonymous with *Siphonodosaria*, as similarly developed from *Siphogenerinoides*. The age range of *Siphonodosaria* seems to preclude *Siphogenerina* as its main parent stock, since *Siphonodosaria* ranges from Upper Cretaceous up through the Tertiary whereas *Siphogenerina* is a Tertiary genus which only became prominent during the Oligocene. One is tempted, therefore, to regard the early forms of *Siphonodosaria* as being developed from *Siphogenerinoides* in the Upper Cretaceous. There is a distinct apertural similarity between normal *Siphonodosaria* and specimens of *Siphogenerinoides*¹⁶ in which the apertural lip is incompletely fused (see Tex Fig. 1, m, n).

In the list which follows attention is drawn to some nodosarian species which seem to fall under *Siphonodosaria* though hitherto usually classified under other genera, principally *Ellipsonodosaria* and *Nodogenerina*.

16. Stone. Jour. Pal., vol. 20, p. 467, pl. 71, figs. 13b, 18b. 21b. 1946.

EXPLANATION OF TEXT FIGURE 1

Outline drawings of uniserial calcareous foraminifera

Siphonodosaria

a, b, *S. abyssorum*, genotype. Type specimens (after Brady). c, d, *S. abyssorum* (?). Apertural views of the Trinidad form ("E. nuttalli") (after Cushman and Jarvis). e, f, *S. abyssorum* (?) var. *gracilima*. Illustrating the dimorphism of the genus (after Cushman and Stainforth). g, *S. verneuili*. Longitudinal section (after Jedlitschka). h, i, j, k, l. Apertural views, respectively, of *S. verneuili* (after Jedlitschka), *S. verneuili*, *S. paucistriata*, *S. subnodosa* and *S. mappa* (after Cushman and Jarvis).

Siphogenerinoides

m, Aperture of specimen with incompletely fused lip (after Stone). n, Aperture of specimen with completely fused lip (after Stone).

Nodosarella (formerly *Ellipsonodosaria*)

o, *N. rotundata*, formerly genotype of *Ellipsonodosaria*. Type specimen (after d'Orbigny). p, *N. chapmani*. Longitudinal section of type specimen (after A. Silvestri).

Ellipsoidella

q, *E. salmojraghi*, typifying *Nodosarella* Cushman (non Rzebak). Longitudinal section of type specimen (after Martinotti). r, *E. pleurostomelloides*, genotype. Cotype specimen (after Heron-Allen and Earland).

Nodosarella

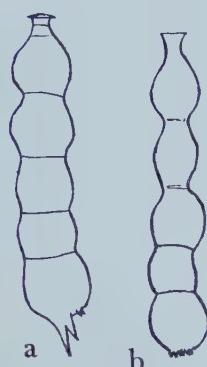
s, *N. tuberosa*, genotype. Type specimen (after Gümbel).

Orthomorphina

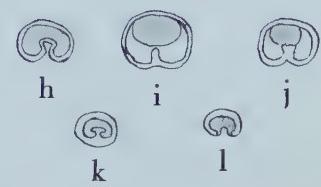
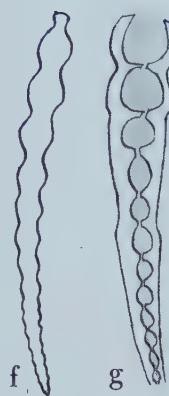
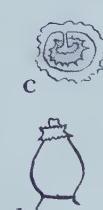
t, u, *O. hayanensis*, proposed genotype. Type specimens (after Cushman and Bermudez). v, *O. jedlitschkai*. Type specimen (after Brady). w, *O. rohri*. Type specimen (after Cushman and Stainforth). x, *O. chalengeriana*. Type specimen (after Brady).

Lagenonodosaria

y, *L. scalaris* var. *sagamiensis*. Cotype specimen (after Asano).



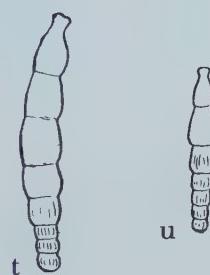
Siphonodosaria



Siphogenerinoides



Nodosarella

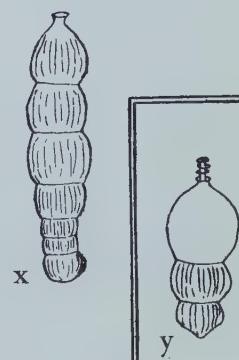


Ellipsoidella



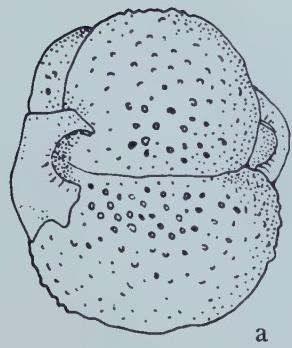
Nodosarella

Orthomorphina

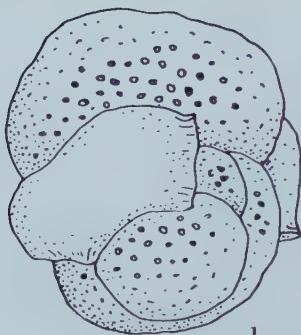


Lagenonodosaria

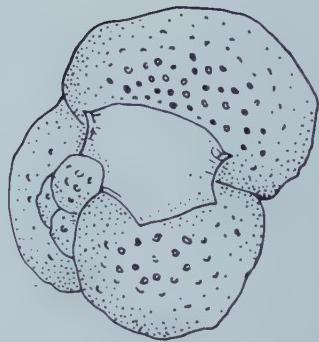
STAINFORTH — Text Figure 1



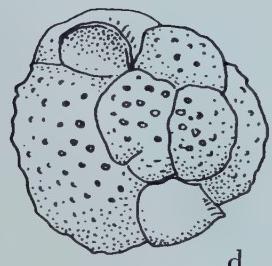
a



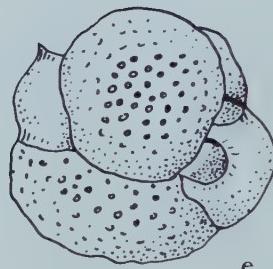
b



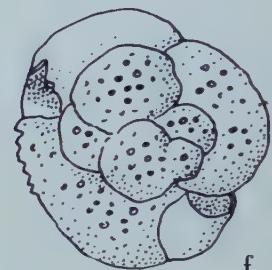
c



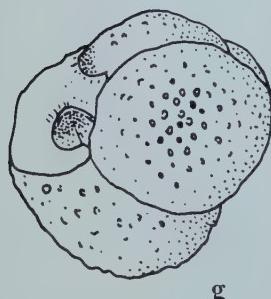
d



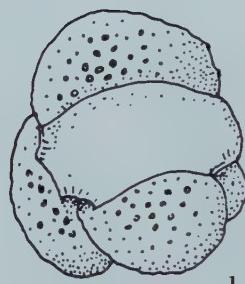
e



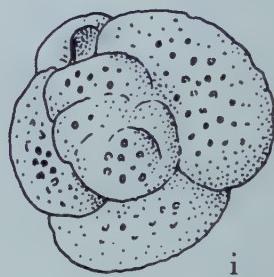
f



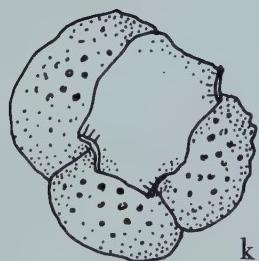
g



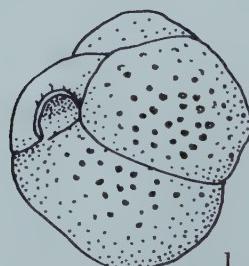
h



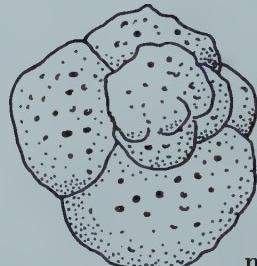
i



k



l



m

BRONNIMANN — Text Figure 1

The synonymy is not intended to be complete, but as far as possible the earliest references are given for each genus under which the various species have been listed. The ubiquitous *Nodosaria* and *Dentalina* of the earlier European authors doubtless include other species of *Siphonodosaria*, but without access to types it is unwise to attempt a revision based on figures alone; for instance *Dentalina verneuili* d'Orb. is a characteristic *Siphonodosaria* but would not be taken as such from the type figure.

***Siphonodosaria abyssorum* (Brady)**

- = *Sagrinodosaria abyssorum* (Brady) Jedlitschka, 1931. (Firgenwald, Reichenberg (Liberec), Czechoslovakia, vol. 4, p. 125, plate. 126, figs. 24, 25)
- = *Siphonodosaria abyssorum* (Brady) Cushman, 1927. (Cushman Lab., Contr., vol. 3, p. 69, pl. 14, fig. 20)
- = *Nodosaria abyssorum* Brady, 1881. (Micr. Soc., Lond., Quart. Jour., n. s., vol. 21, p. 63; Challenger Exped. 1873-76, Rept. Zool. vol. 9, p. 504, pl. 63, figs. 8, 9)

***S. abyssorum* (?) (Brady)**

- = *S. nuttalli* (Cushman and Jarvis) Glaessner, 1937. (Moscow Univ., Lab. Pal. Prob. Pal., vol. 2-3, p. 377)
- = *Ellipsonodosaria nuttalli* Cushman and Jarvis, 1934. (Cushman Lab., Contr., vol. 10, p. 72, pl. 10, figs. 6a, b)
- = *Nodosaria abyssorum* Brady, Guppy, 1904. (Victoria Inst., Trinidad, Proc., vol. 2, p. 12, pl. 1, figs. 10, 11)

***S. abyssorum* (?) (Brady) var. *aculeata* (Cushman and Renz)**

- = *Ellipsonodosaria nuttalli* Cushman and Jarvis var. *aculeata* Cushman and Renz, 1948. (Cushman Lab., Spec. Publ. 24, p. 32, pl. 6, fig. 10)

***S. abyssorum* (?) (Brady) var. *gracillima* (Cushman and Jarvis)**

- = *S. nuttalli* (Cushman and Jarvis) var. *gracillima* (Cushman and Jarvis) Bermudez, 1949. (Loc. cit., Spec. Publ. 25, p. 226, pl. 14, figs. 22, 23)
- = *Ellipsonodosaria nuttalli* var. *gracillima* Cushman and Jarvis, 1934. (Loc. cit., Contr., vol. 10, p. 72, pl. 10, figs. 7a, b)

***S. adelinensis* (Palmer and Bermudez)**

- = *S. adelinensis* (Palmer and Bermudez) Bermudez, 1950. (Soc. Cubana Hist. Nat., mem., vol. 19, no. 3, chart, p. 361)
- = *Ellipsonodosaria* (?) *adelinensis* Palmer and Bermudez, 1936. (Loc. cit., vol. 10, p. 299, pl. 18, fig. 13)

***S.adolpina* (d'Orbigny)**

- = *S.adolpina* (d'Orbigny) Glaessner, 1937. (Moscow Univ., Lab. Pal., Prob. Pal., vol. 2-3, pp. 376-377)
- = *Nodogenerina adolpina* (d'Orb.) Jedlitschka, 1935. (Naturf. Ver. Brünn, Verh., Brünn (Brno), Czechoslovakia, vol. 66 (1934), p. 67)
- = *Dentalina adolpina* d'Orbigny, 1846. (Foraminifères fossiles du bassin tertiaire de Vienne (Autriche), Gide et Cie., Paris, P. 51, pl. 2, figs. 18-20)

***S. advena* (Cushman and Laiming)**

- = *Nodogenerina advena* Cushman and Laiming, 1931. (Jour. Pal., vol. 5, p. 106, pl. 11, fig. 19)

***S. alexanderi* (Cushman)**

- = *Ellipsonodosaria alexanderi* Cushman, 1936. (Cushman Lab., Contr., vol. 12, p. 52, pl. 9, figs. 6-9)

***S. alexanderi* var. *impensa* (Cushman)**

- = *Ellipsonodosaria alexanderi* var. *impensa* Cushman, 1938. (Op. cit., vol. 14, p. 48, pl. 8, figs. 4, 5)

***S. annulifera* (Cushman and Bermudez)**

- = *S. annulifera* (Cushman and Bermudez) Bermudez, 1950. (Soc. Cubana Hist. Nat., mem., vol. 19, no. 3, chart, p. 361)

- = *Ellipsonodosaria annulifera* Cushman and Bermudez, 1936. (Cushman Lab., Contr., vol. 12, p. 28, pl. 5, figs. 8, 9)

***S. antillea* (Cushman)**

- = *Nodogenerina antillea* (Cushman) Church, 1928. (Jour. Pal., vol. 1, p. 267)

- = *Nodosaria antillea* Cushman, 1923. (U. S. Nat. Mus., Bull., no. 104, p. 91, pl. 14, fig. 9)

***S. atlantica* (Cushman)**

- = *Ellipsonodosaria atlanticae* Cushman, 1939. (Cushman Lab., Contr., vol. 15, p. 70, pl. 12, figs. 3, 4)

***S. atlanticae* (Cushman) var. *hispidula* (Cushman)**

- = *Ellipsonodosaria atlanticae* var. *hispidula* Cushman, 1939. (Loc. cit., fig. 5)

***S. bradyi* (Cushman)**

- = *S. bradyi* (Cushman) Galloway, 1933. (Manual of foraminifera, Bloomington, Ind., pl. 34, fig. 11)

- = *Nodogenerina bradyi* Cushman, 1927. (Cushman Lab., Contr., vol. 2, p. 79)

***S. calvertensis* (Cushman)**

- = *Ellipsonodosaria calvertensis* Cushman, 1948. (Maryland Dept. Geol., Mines and Water Res., Bull., no. 2, p. 223, pl. 15, figs. 14, 15)

***S. camerani* (Dervieux)**

- = *Ellipsonodosaria camerani* (Dervieux) Silvestri, 1923. (Riv. Ital. Pal., Parma, vol. 29, fasc. 1-2, pp. 16-22, pl. 2, figs. 4-12; pl. 18, txfs. 4a, b, 5a, b; p. 20, txfs. 9b, 10b, 12b)

- = *Nodosaria camerani* Dervieux, 1894. (Soc. Geol. Ital., Boll., vol. 12, p. 612, pl. 5, figs. 40, 41)

***S. caribaea* (Palmer and Bermudez)**

- = *S. caribaea* (Palmer and Bermudez) Bermudez, 1950. (Soc. Cubana Hist. Nat., mem., vol. 19, no. 3, chart, p. 361)

- = *Ellipsonodosaria caribaea* Palmer and Bermudez, 1936. (Loc. cit., vol. 10, p. 297, pl. 18, figs. 10, 11)
This is not *E. caribaea* Palmer, 1945 (Bul. Am. Pal., vol. 29, no. 115, p. 53) which is an invalid homonym, possibly synonymous with *S. abyssorum* (?) var. *gracillima* (Cushman and Jarvis).

***S. cienegaensis* (Kleinpell)**

- = *Nodogenerina cienegaensis* Kleinpell, 1938. (Miocene Stratigraphy of California, Am. Ass. Petr. Geol., p. 244, pl. 6, fig. 4)

***S. cocaensis* (Cushman)**

- = *S. cocaensis* (Cushman) Bermudez, 1950. (Soc. Cubana Hist. Nat., mem., vol. 19, no. 3, chart, p. 361)

- = *Ellipsonodosaria cocaensis* (Cushman) Cushman, 1939. (Cushman Lab., Contr., vol. 15, p. 68, pl. 11, figs. 27-33)

- = *Nodosaria cocaensis* Cushman, 1925. (Op. cit., vol. 1, p. 66, pl. 10, figs. 5, 6)

EXPLANATION OF TEXT FIGURE 1

TEXT FIGS.

- 1 a-m *Globigerinoides morugaensis* Bronnimann, Lengua formation, Basal Miocene, Moruga area, Trinidad, B.W.I. T.L.L. Cat. No. 3514, All appr. 75 \times . 4 individuals, each figured from 3 different angles (a-c, d-f, g-i, and k-m). a, b, c, Holotype. a-f, with dual supplementary growth. c, showing chamberlike cover issued by the small *Globigerinoides* aperture. g-m, incomplete individuals with chamberlike growth across umbilicus. *Globigerinoides* aperture not visible.

- S. consobrina** (d'Orbigny)
 = **Nodogenerina consobrina** (d'Orbigny) Marks, 1951. (Cushman Found. Foram. Res., Contr., vol. 2, p. 55)
 = **Dentalina consobrina** d'Orbigny, 1846. (Foram. foss. Vienne, p. 46, pl. 2, figs. 1-3)
- S. cooperensis** (Cushman)
 = **Nodogenerina cooperensis** Cushman, 1933. (Op. cit., vol. 9, p. 11, pl. 1, fig. 27)
- S. curvatura** (Cushman)
 = **S. curvatura** (Cushman) Bermudez, 1950. (Soc. Cubana Hist. Nat., mem., vol. 19, no. 3, p. 361)
 = **Ellipsonodosaria curvatura** Cushman, 1939. (Cushman Lab., Contr., vol. 15, p. 71, pl. 12, fig. 6)
- S. dentaliniformis** (Cushman and Jarvis)
 = **S. dentaliniformis** (Cushman and Jarvis) Bermudez, 1949. (Loc. cit., Spec. Publ. 25, p. 225, pl. 14, fig. 28)
 = **Ellipsonodosaria dentaliniformis** Cushman and Jarvis, 1934. (Loc. cit., Contr., vol. 10, p. 73, pl. 10, fig. 9)
- S. dentata-glabrata** (Cushman)
 = **Ellipsonodosaria dentata-glabrata** Cushman, 1936. (Op. cit., vol. 12, p. 54, pl. 9, figs. 22, 23)
- S. elegans** (d'Orbigny)
 = **Nodogenerina elegans** (d'Orb.) Marks, 1951. (Cushman Found. Foram. Res., Contr., vol. 2, p. 55)
 = **Dentalina elegans** d'Orbigny, 1846. (Foram. foss. Vienne, p. 45, pl. 1, figs. 52-56)
- S. fistuca** (Schwager)
 = **Nodosaria fistuca** Schwager, 1866. (Novara Exped. 1857-59, Geol. Theil., bd. 2, abt. 2, p. 216, pl. 5, figs. 36, 37. Vienna) (also = **Ellipsonodosaria fistuca** and **Lagenodosaria fistuca** of authors)
- S. georgiana** (Cushman)
 = **Nodogenerina georgiana** Cushman, 1935. (Cushman Lab., Contr., vol. 11, p. 80, pl. 12, fig. 16)
- S. gracilis** (Palmer and Bermudez)
 = **S. gracilis** (Palmer and Bermudez) Bermudez, 1949. (Loc. cit., Spec. Publ. 25, p. 225, pl. 14, fig. 27)
 = **Ellipsonodosaria gracilis** Palmer and Bermudez, 1936. (Soc. Cubana Hist. Nat., vol. 10, p. 296, pl. 18, figs. 8, 9)
- S. granulifera** (Galloway and Heminway)
 = **Nodosarella constricta** Cushman and Bermudez var. **granulifera** Galloway and Heminway, 1941. (New York Acad. Sci., Sci. Surv. Porto Rico and Virgin Is., vol. 3, p. 439, pl. 35, fig. 5) (Bermudez refers this species to **Nodosarella tuckerae** (Hadley); see Cushman Lab., Spec. Publ. 25, p. 232, 1949)
- S. harrisi** (Cole)
 = **Nodosaria harrisi** Cole, 1927. (Bul. Am. Pal., vol. 14, no. 51, p. 16, pl. 3, fig. 2) (Not **N. harrisi** Vieaux, 1941, an invalid homonym)
- S. helenae** (Samoilova)
 = **Ellipsonodosaria helenae** Samoilova, 1947. (Soc. Nat. Moscow Bull., n. s., tome 52 (séct. géol., tome 22), no. 4, pp. 90, 100; p. 87, txfs. 22, 23)
- S. hispida** (Soldani)
 = **Nodogenerina hirsuta** (Soldani), (sic) Marks, 1951. (Cushman Found. Foram. Res., Contr., vol. 2, p. 56, pl. 7, fig. 7)
 = **Nodosaria hispida** (Soldani) d'Orbigny, 1846 (1839?) (non Schwager, 1866) (Foram. foss. Vienne, p. 35, pl. 1, figs. 24, 25)
 = **Nodosaria hirsuta** d'Orbigny, 1826. (Ann. Sci. Nat., vol. 7, p. 252, Paris)
 = **Orthoceratia hispida** Soldani, 1798. (Testaceographiae, vol. 2, p. 15, tab. 2, fig. 31 P; vol. 6, tab. 11, fig. f. hh. Siena, Italy) (see: Parker, Jones and Brady, 1871, Ann. Mag. Nat. Hist., ser. 4, vol. 8, p. 154, London).
- S. horridens** (Cushman)
 = **Ellipsonodosaria horridens** Cushman, 1936. (Cushman Lab., Contr., vol. 12, p. 53, pl. 9, figs. 19-21)
- S. indica** (LeRoy)
 = **Ellipsonodosaria indica** LeRoy, 1944. (Colorado School of Mines, Quart., vol. 39, no. 3, p. 79, pl. 1, fig. 24)
- S. irregularis** (Kleinpell)
 = **Nodogenerina irregularis** Kleinpell, 1938. (Miocene Stratigraphy of California, Am. Ass. Petr. Geol., p. 245, pl. 17, fig. 12)
- S. jabacoensis** (Bermudez)
 = **S. jabacoensis** (Bermudez) Bermudez, 1950. (Soc. Cubana Hist. Nat., mem., vol. 19, no. 3, chart p. 361)
 = **Ellipsonodosaria jabacoensis** Bermudez, 1937. (Op. cit., vol. 11, p. 239, pl. 20, figs. 4, 5)
- S. jacksonensis** (Cushman and Applin)
 = **Dentalina jacksonensis** (Cushman and Applin) Cushman, 1935. (U. S. Geol. Surv., Prof. Pap. 181, p. 20, pl. 8, figs. 7-9)
- = **Nodosaria jacksonensis** Cushman and Applin, 1926. (Am. Ass. Petr. Geol., Bull., vol. 10, p. 170, pl. 7, figs. 14-16)
- S. jarvisi** (Cushman)
 = **S. jarvisi** (Cushman) Glaessner, 1937. (Moscow Univ., Lab. Pal., Prob. Pal., vol. 2-3, pp. 375-376, pl. 2, figs. 22, 23)
 = **Ellipsonodosaria (?) jarvisi** Cushman, 1936. (Cushman Lab., Contr., vol. 12, p. 53, pl. 9, figs. 16-18)
- S. lepidula** (Schwager)
 = **S. lepidula** (Schwager) Glaessner, 1937. (Moscow Univ., Lab. Pal., Prob. Pal., vol. 2-3, p. 376)
 = **Ellipsonodosaria lepidula** (Schwager) Cushman, 1939. (Geol. Soc. Japan, Jour., vol. 46, no. 546, p. 150)
 = **Nodogenerina lepidula** (Schwager) Cushman, Stewart and Stewart, 1930. (San Diego Soc. Nat. Hist., Trans., vol. 6, pp. 63, 64, pl. 4, fig. 5)
 = **Nodosaria lepidula** Schwager, 1866. (Novara Exped. 1857-59, Geol. Theil., bd. 2, abt. 2, p. 210, pl. 5, figs. 27, 28)
- S. lohmani** (Kleinpell)
 = **Nodogenerina lohmani** Kleinpell, 1938. (Miocene Stratigraphy of California, Am. Ass. Petr. Geol., p. 245, pl. 4, fig. 6)
- S. mappa** (Cushman and Jarvis)
 = **Ellipsonodosaria mappa** Cushman and Jarvis, 1934. (Cushman Lab., Contr., vol. 10, p. 73, pl. 10, fig. 8)
- S. matanzana** (Palmer and Bermudez)
 = **S. matanzana** (Palmer and Bermudez) Bermudez, 1950. (Soc. Cubana Hist. Nat., mem., vol. 19, no. 3, chart, p. 361)
 = **Ellipsonodosaria (?) matanzana** Palmer and Bermudez, 1936. (Op. cit., vol. 10, p. 298, pl. 18, fig. 12)
- S. midwayensis** (Cushman and Todd)
 = **Ellipsonodosaria midwayensis** Cushman and Todd, 1946. (Cushman Lab., Contr., vol. 22, p. 61, pl. 10, fig. 25)
 = **Nodosaria spinulosa** (Montagu) Plummer, 1927. (Univ. Texas, Bull., no. 2644, p. 84, pl. 4, fig. 9)
- S. minuta** (Cushman)
 = **Ellipsonodosaria minuta** Cushman, 1938. (Cushman Lab., Contr., vol. 14, p. 48, pl. 8, fig. 6)
- S. modesta** (Bermudez)
 = **S. modesta** (Bermudez) Bermudez, 1949. (Loc. cit., Spec. Publ. 25, p. 225, pl. 14, fig. 29)
 = **Ellipsonodosaria modesta** Bermudez, 1937. (Soc. Cubana Hist. Nat., mem., vol. 11, p. 238, pl. 20, fig. 3)
- S. modesta** (Bermudez) var. **prolata** (Cushman and Bermudez)
 = **S. modesta** (Bermudez) var. **prolata** (Cushman and

- Bermudez) Bermudez, 1950. (Loc. cit., vol. 19, no. 3, chart p. 361)
- = *Ellipsonodosaria modesta* Bermudez var. *prolata* Cushman and Bermudez, 1937. (Cushman Lab., Contr., vol. 13, p. 109, pl. 16, figs. 1, 7)
- S. monilis** (O. Silvestri)
- = *S. monilis* (O. Silvestri) Glaessner, 1937. (Moscow Univ., Lab. Pal., Prob. Pal., vol. 2-3, p. 376)
- = *Nodosaria monilis* O. Silvestri, 1872. (Accad. Gioenia Sci. Nat. Catania (Italy), Atti, ser. 3, tomo 7, p. 71, pl. 8, figs. 173-183)
- (For *S. nuttalli* see *S. abyssorum* (?))
- S. paleocenica** (Cushman and Todd)
- = *Ellipsonodosaria paleocenica* Cushman and Todd, 1946. (Cushman Lab., Contr., vol. 22, p. 61, pl. 10, fig. 26)
- S. paucistriata** (Galloway and Morrey)
- = *S. paucistriata* (Galloway and Morrey) Bermudez, 1949. (Loc. cit., Spec. Publ. 25, p. 226, pl. 14, fig. 25)
- = *Ellipsonodosaria verneuili* (d'Orb.) var. *paucistriata* (G. and M.) Cushman, 1929. (Loc. cit., Contr., vol. 5, p. 97)
- = *Nodosarella paucistriata* Galloway and Morrey, 1929. (Bull. Am. Pal., vol. 15, no. 55, p. 42, pl. 6, fig. 12)
- = *Nodosaria intermittens* Nuttall, 1928 (not Roemer, 1838). (Geol. Soc. London, Quart. Jour., vol. 84, p. 82, pl. 4, fig. 7)
- S. pauperata** (d'Orbigny)
- = *Nodogenerina pauperata* (d'Orbigny) Marks, 1951. (Cushman Found. Foram. Res., Contr., vol. 2, p. 56, pl. 7, fig. 6)
- = *Ellipsonodosaria pauperata* (d'Orb.) Krejci-Graf and Liebus, 1935. (Neues Jahrb. f. Min., Geol. und Pal., vol. 74, B, p. 125, Stuttgart)
- = *S. pauperata* (d'Orb.) Jedlitschka, 1935. (Naturf. Ver., Brünn (Brno), Czechoslovakia, vol. 66, pp. 63-66, 71; p. 70, tf. la-h)
- = *Dentalina pauperata* d'Orbigny, 1846. (Foraminifères fossiles du bassin tertiaire de Vienne (Autriche), p. 46, pl. 1, figs. 57, 58. Gide et Cie., Paris)
- S. pilulata** (Cushman and Todd)
- = *Ellipsonodosaria pilulata* Cushman and Todd, 1948. (Cushman Lab., Contr., vol. 24, p. 5, pl. 2, fig. 8; idem, p. 46)
- S. plummerae** (Cushman)
- = *Ellipsonodosaria plummerae* Cushman, 1940. (Op. cit., vol. 16, p. 69, pl. 12, figs. 4, 5)
- S. pseudoscripta** (Cushman)
- = *Ellipsonodosaria pseudoscripta* Cushman, 1937. (Op. cit., vol. 13, p. 103, pl. 15, fig. 14)
- S. punctata** (d'Orbigny)
- = *Nodogenerina punctata* (d'Orbigny) Marks, 1951. (Cushman Found. Foram. Res., Contr., vol. 2, p. 56)
- = *Dentalina punctata* d'Orbigny, 1846. (Foram. Foss. Vienne, p. 46, pl. 2, figs. 14, 15)
- S. recta** (Palmer and Bermudez)
- = *S. recta* (Palmer and Bermudez) Bermudez, 1949. (Loc. cit., Spec. Publ. 25, p. 227, pl. 14, fig. 26)
- = *Ellipsonodosaria recta* Palmer and Bermudez, 1936. (Soc. Cubana Hist. Nat., mem., vol. 10, p. 297, pl. 18, figs. 6, 7)
- S. sagrinensis** (Bagg)
- = *Nodogenerina sagrinensis* (Bagg) Jedlitschka, 1935. (Naturf. Ver., Brünn (Brno), Czechoslovakia, vol. 66, p. 69)
- = *Nodosaria sagrinensis* Bagg, 1912. (U. S. Geol. Surv. Bull. no. 513, p. 58, pl. 16, fig. 4) (not *N. sagrinensis* Storm, 1929, an invalid homonym)
- S. sanctaeerucis** (Kleinpell)
- = *Nodogenerina sanctaeerucis* Kleinpell, 1938. (Mio-
- cene Stratigraphy of California, Am. Ass. Petr. Geol., p. 246, pl. 4, fig. 22)
- S. scripta** (d'Orbigny)
- = *Nodogenerina scripta* (d'Orbigny) Marks, 1951. (Cushman Found. Foram. Res., Contr., vol. 2, p. 56)
- = *Dentalina scripta* d'Orbigny, 1846. (Foram. Foss. Vienne, p. 51, pl. 2, figs. 21, 23)
- S. semijugosa** (Cushman)
- = *Ellipsonodosaria semijugosa* Cushman, 1939. (Cushman Lab., Contr., vol. 15, p. 69, pl. 12, figs. 1, 2)
- S. spinata** (Cushman)
- = *Nodogenerina spinata* Cushman, 1934. (Bernice P. Bishop Mus., Bull. no. 119, p. 123, pl. 14, fig. 14)
- S. spinescens** (Reuss)
- = *S. spinescens* (Reuss) Glaessner, 1937. (Moscow Univ., Lab. Pal., Prob. Pal., vol. 2-3, p. 376)
- = *Dentalina spinescens* Reuss, 1851. (Deutsch Geol. Ges., Zeitschr., bd. 3, p. 62, pl. 3, fig. 10)
- S. stephensi** (Cushman)
- = *Ellipsonodosaria stephensi* Cushman, 1936. (Cushman Lab., Contr., vol. 12, p. 52, pl. 9, figs. 10-15)
- S. stephensi** var. *speciosa* (Cushman)
- = *Ellipsonodosaria stephensi* var. *speciosa* Cushman, 1938. (Op. cit., vol. 14, p. 47, pl. 8, fig. 3)
- S. subspinosa** (Cushman)
- = *Ellipsonodosaria subspinosa* Cushman, 1943. (Op. cit., vol. 19, p. 92, pl. 16, figs. 6, 7)
- = *Ellipsonodosaria* sp. (?) Cushman and Jarvis, 1934. (Op. cit., vol. 10, pl. 10, figs. 4, 5)
- S. verneuilli** (d'Orbigny)
- = *Nodosarella verneuilli* (d'Orb.) Galloway and Hemmingsway, 1941. (New York Acad. Sci., Sci. Surv. Porto Rico and Virgin Is., vol. 3, pt. 4, p. 440, pl. 35, fig. 10)
- = *S. verneuilli* (d'Orb.) Oppel, 1934. (Naturf. Ver., Brno (Brünn), Czechoslovakia, Verh., vol. 65, p. 55, pl. 1, figs. 17-19, 21-23, 24a-g)
- = *Sagrinodosaria verneuilli* (d'Orb.) Jedlitschka, 1931. (Firgenwald, Reichenberg (Liberec), Czechoslovakia, vol. 4, pp. 122-125; pl. p. 126, figs. 1-23)
- = *Ellipsonodosaria verneuilli* (d'Orb.) Cushman, 1929. (Cushman Lab., Contr., vol. 5, pp. 96-97, pl. 14, figs. 1-3)
- = *Nodosaria verneuilli* (d'Orb.) Nuttall, 1928. (Geol. Soc. Lond., Quart. Jour., vol. 84, p. 81, pl. 4, figs. 14, 15)
- = *Dentalina verneuilli* d'Orbigny, 1846. (Foraminifères fossiles du bassin tertiaire de Vienne (Autriche), p. 48, pl. 2, figs. 7, 8; Gide et Cie., Paris)
- S. verneuilli** (d'Orb.) var. *emaciata* (Palmer and Bermudez)
- = *S. verneuilli* (d'Orb.) var. *emaciata* (Palmer and Bermudez) Bermudez, 1950. (Soc. Cubana Hist. Nat., mem., vol. 19, no. 3, chart p. 361)
- = *Ellipsonodosaria verneuilli* (d'Orb.) var. *emaciata* Palmer and Bermudez, 1941. (Op. cit., vol. 15, p. 189, pl. 18, figs. 14-16)
- S. volgensis** (Samoilova)
- = *Ellipsonodosaria volgensis* Samoilova, 1947. (Soc. Nat. Moscou, Bull., n. s., tome 52 (sect. géol. tome 22), no. 4, pp. 89, 100; p. 87, tfs. 20, 21)
- There is a small group of nodosarian foraminifera which can not be placed under *Siphonodosaria* or *Orthomorphina* despite some superficial resemblance. A species that may be taken as typical of the group is *Nodosaria aculeata* d'Orb., 1846. Many others, probably partly synonymous, were described under *Nodosaria* by d'Orbigny, Neugeboren, Reuss and later authors. The main features are a small number (three to five) of chambers, evenly arranged, globose, and usually striate or hispid; the aperture is simple, at the

end of a long thin tube frequently ornamented by multiple rings or collars: the final chamber considered alone is frequently strongly suggestive of one or other species of *Lagena*. If the name *Nodosaria* is to be reserved for species with radiate apertures, some other name is required for this group. *Lagenonodosaria* A.

Silvestri, 1900 (genotype *Nodosaria scalaris* Bartsch var. *separans* Brady)¹⁷ appears valid for the purpose and seems to deserve a wider acceptance than it has yet achieved.

17. Accad. Sci. Lettere Arti Acireale, Cl. Sci., Atti Rend., n. s., vol. 10 (1898-1900), mem. 5, p. 3. Acireale, Sicily, 1900.

45. NEW NAMES FOR NORTHWESTERN GULF OF MEXICO FORAMINIFERA

FRED B PHLEGER and FRANCES L. PARKER
La Jolla, California

Hans E. Thalmann has called our attention to three homonyms in our recent publication on Northwestern Gulf of Mexico Foraminifera. The following new names are proposed:

Bolivina ordinaria Phleger and Parker, n. name
For: *Bolivina simplex* Phleger and Parker, 1951, Mem. 46, Geol. Soc. America, p. 14, pl. 7, figs. 4-6; not *Bolivina interjuncta* Cushman var. *simplex* Cushman and Renz, 1941, Contr. Cushman Lab. Foram. Res., vol. 17, p. 20, pl. 3, fig. 15. (Later called *Bolivina simplex* by Renz, 1948, Mem. 32, Geol. Soc. America, p. 119, pl. 7, fig. 4). Middle Miocene of Venezuela.

Cibicides corpulentus Phleger and Parker, n. name

For: *Cibicides robustus* Phleger and Parker, 1951, Mem. 46, Geol. Soc. America, p. 31, pl. 17, figs. 1-4; not *Cibicides robustus* Le Calvez, 1949, Mém. Explic. Carte Géol. dét. France, p. 47, pl. 4, figs. 57-59. Lu-tetian, Paris Basin, France.

Loxostomum abruptum Phleger and Parker, n. name

For: *Loxostomum truncatum* Phleger and Parker, 1951, Mem. 46, Geol. Soc. America, p. 17, pl. 7, figs. 15-19; not *Loxostomum truncatum* Finlay, 1947, New Zealand Jour. Sci. and Technol., vol. 28, sect. b, p. 280, pl. 6, figs. 91-96. Middle Miocene of New Zealand.

46. NEW NAMES FOR FORAMINIFERAL HOMONYMS. I.

HANS E. THALMANN
Stanford University

The following new names are herewith proposed with the authorization by Jan Hofker (letter dated The Hague, December 16th, 1951):

Conorboides Hofker, nom. nov.
For: *Conorbis* Hofker, 1951, Siboga-Exped., Monograph IV a, Foraminifera, part 3, p. 418 (non *Conorbis* Swainson, 1840, Treat. Malacol., p. 149, 312, Mollusca). Lower Cretaceous.

Allomorphina fragilis Hofker, nom. nov.
For: *Allomorphina pacifica* Hofker, 1951, op. cit., p.

139, text fig. 86, Recent, Indonesia (non *Allomorphina pacifica* Cushman and Todd, 1949, Cushman Labor. Form. Res., Contr., vol. 25, p. 68, pl. 12, figs. 6-9, Pliocene, Fiji).

Schenckella exigua (Hofker) nom. nov.

For: *Listerella minuta* Hofker, op. cit., p. 27, text fig. 6, Recent, Indonesia, (non *Listerella minuta* Hussey, 1949, Jour. Paleont., vol. 23, p. 119, pl. 26, fig. 2, Middle Eocene, Louisiana). This homonym is herewith allocated to the genus *Schenckella* Thalmann, 1942 (see: Amer. Midland Naturalist, vol. 28, 1942, p. 458).

47. STUDIES ON RECENT ALLOGROMIIDAE: 1. MICROMETULA HYALOSTRIATA N. GEN., N. SP., FROM THE GULLMAR FJORD, SWEDEN

KARL-GEORG NYHOLM
Department of Zoology, University of Uppsala

When studying the microfauna from the detritus-layer on soft sediments in the Gullmar Fjord at the

Zoological Station Kristineberg a rhizopod with a hyaline test was found in large quantities at certain local-

ties between a depth of 30 and 118 meters. It seems that this form had not been observed by previous workers on account of its light weight when compared with other microforms of about the same size. Repeated rinsings of bottom samples followed by decanting may easily wash away such tender forms. They can best be observed and collected by thorough examination of fresh bottom sample by means of a binocular dissection microscope.

Genus *Micrometula* Nyholm, n. gen.

Genotype.—*Micrometula hyalostriata* Nyholm, n. sp. (metula = cone)

Description.—Cone-shaped organism with a hyaline chitinoid envelope. Test imperforate, no plasma outside test, striated from top to base. Permanent rounded aperture at base; a temporary smaller aperture can exist at top. Cytoplasm without microscopical detritus, usually one nucleus present. Size: 0.7 to 1.2 mm.

Occurrence: On detritus layer of muddy soft bottoms, depth: 30 to 118 meters. Gullmar Fjord, Sweden.

Micrometula hyalostriata Nyholm, n. sp.

Plate 4, figures 1-10; Plate 5, figure 8; Text figure 1

Description.—As above.

Remarks.—The pseudopodia-plasm of the basal part of the test attaches the organism in the detritus layer of the sediment. Living specimens, when removed from the sample, show detritus adhering to the aperture when the pseudopodia contract (Plate 4, fig. 2d). Diameter of basal aperture approximately 8μ.

A narrow opening may be detected in the apical part of the test which portion is extremely fragile. In intact specimens the cytoplasm fills the apical region (Plate 4, figs. 2 and 3). This apical aperture may not be permanent because, when irritated by strong light, the plasm in the upper part of the apical cone contracts thus closing the aperture entirely. (Plate 4, figs. 4 and 5). Plasma has not been found outside the envelope. Investigation by electron-microscope indicates that the test is imperforate. Foreign bodies have not been observed at the sides of the test. Detritus particles accumulate at the apertures only. Principal food ingestion probably takes place through the basal aperture although some detritus was observed also at the apical end of the test (Plate 4, fig. 2).

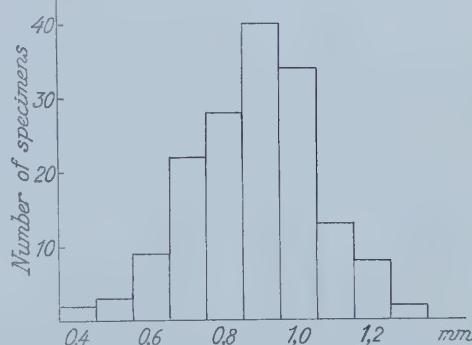
Usually only one nucleus was observed in *Micrometula* (see Plate 4, fig. 9), which shows the nucleus in the vegetative phase.

In a number of specimens transverse puckering in the test were observed which correspond to puckering in the plasm (Plate 4, figs. 6 and 7). In fossil specimens such puckering would possibly be interpreted as signs of transverse division. Although it has not been observed in living specimens it is possible that the upper part of the test could separate itself from the

lower part and anchor with the substratum at the point of cleavage-surface.

Sections of numerous specimens with the above-mentioned puckering show only one nucleus in the vegetative phase, always in the upper part of the test. Nuclear changes in rhizopoda often occur very quickly. Insufficient support in the nuclear conditions for a transverse division in such a case would not exclude transverse division as a possible type of propagation but should increase the efforts made to bring a more extensive cytological material under control. So far, *Micrometula* could not yet be cultivated on a large scale. Material was collected during different times of the year. It was studied alive or as preserved material in Muller's, Zenker's, Bovin's and Kleinenberg's fluids. Embedding and sectioning took place after methylbenzoate treatment.

Micrometula hyalostriata
160 specimens from the Gullmar Fjord



Text Fig. 1. Diagram showing variation of body-length in *Micrometula hyalostriata* Nyholm

The following observations are mentioned with regard to the possible method of propagation in *Micrometula*: occasionally minute specimens are found at the base of the largest individual. They could scarcely have been produced by transverse cleavage, and it is just as improbable that they resulted from longitudinal cleavage. It remains, therefore, to be proved that these minute specimens originated from asexual reproductive bodies which had left the mother animal by way of the basal aperture, and thereby became situated at the base of the larger individuals. Similar phenomena occur in species of *Bathysiphon*.

Discussion.—I have seldom seen empty tubes of *Micrometula* in Recent detrital layers although empty tests of Allogromiids and other Monothalamia are often observed. Tests of Allogromiidae without plasma but with metabolic remains of a detritus-like nature are not unfrequent on soft bottoms, but this is not the case with *Micrometula*. The mode of ingestion of food in benthonic rhizopoda is still poorly understood. Obvi-

ously, no storage of detritus takes place in the plasma of *Micrometula*. This is, however, the case in some species of *Allogromia*. Absence of detrital inclusions in the plasma of *Micrometula* accelerates the break-down of detritus. The cellulose and carotenoids in detritus requires a relatively long time for decomposition. The swift process of breaking down chitinoid substance relatively free from resistant inclusions by the action of chitinoclastic bacteria (ZoBell and Rittenberg, and others) probably strictly limits the possibility of finding *Micrometula* and similar forms with chitinoid tests either as subfossil or fossil in spite of the fact that they belong to the more primitive Monothalamia.

Insufficient knowledge of the plasmatic conditions in the known Monothalamia makes it difficult to allocate new forms to established families. On the other hand it is highly inadvisable to erect new families for every new form. *Micrometula* is, however, not related to the genus *Allogromia*, which already includes a number of different types, all having one terminal aperture only. The appearance of a temporary aperture at both ends of the tubular test in *Micrometula* indicates a relationship with the Rhizamminidae. This latter family includes, however, genera which characteristically form their tests with agglutinated foreign material, sand, sponge spicules, etc. Such is not the case in *Micrometula*. It is therefore found advisable to defer the taxonomic classification of *Micrometula* until more is known about the genera with exclusive chitinoid tests.

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EXPLANATION OF PLATE 3

FIGS.

PAGE

- 1-3. *Anchispirocyclina henbesti* Jordan and Applin, n. gen., n. sp. Paratypes. Fig. 1, Oblique equatorial section of microspheric specimen. Figs. 2, 3, Subaxial sections of microspheric specimens. All from core, 9115 to 9116 feet in the Standard Oil Company's, (New Jersey) Cape Hatteras Light well no. 1, (N. C. Esso no. 1) Dare County, North Carolina. $\times 30$ 4

Photographs by N. W. Shupe, U. S. Geological Survey



Jordan and Applin: *Choffatella* and *Anchispirocyclina*

Nyholm: *Micrometula hyalostriata*, n. gen., n. sp.

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48. THE GENOTYPE OF SIPHOCERINA

ORVILLE L. BANDY

University of Southern California

In a recent article, Bandy and Burnside presented the view that the genotype of the genus *Siphocerina* should be the first-mentioned species of that genus (*S. glabra*) (1951, p. 14). Since publication of that article, it has been brought to the attention of the senior author that inasmuch as *S. glabra* and *S. costata* appeared in the same article, they would be considered to be published simultaneously by the Joint Rules Committee on Zoological Nomenclature for Paleontology in America (Frizzell, 1951); hence, subsequent designation by Cushman of *S. costata* Schlumberger is valid (Cushman, 1927). The matter even so is neither simple nor settled, for some authors place *S. costata* in synonymy with the earlier form *S. raphanus* (Parker and Jones) (Galloway, 1933, pp. 348, 374); other authors prefer to separate the two (Mathews, 1945). The differences between the two species cited by Mathews are: "(1) *S. costata* has five or six costae; *S. raphanus* usually has ten or twelve. (2) The test of *S. costata* is constricted near the final chamber; the test of *S. raphanus* is not. (3) The aperture of *S. costata* is small; the aperture of *S. raphanus* is large (see type figures)." Regarding the first point of difference, an examination of the specimens from Tahiti shows that the number of costae is quite variable; indeed, as observed in Plate 5, fig. 1, it may be noted that the number increases with age. Mathews also examined specimens from the Society Islands and he

reported one specimen with as few as 7 costae — this author observed as much if not more variation. Concerning the second point, constriction of the final chamber, an examination of the type figure of *S. costata* shows clearly that there is a tendency for constriction toward the final chamber; however, this is frequently an individual variation observable in many other species. The third difference regarding the apertural character is untenable inasmuch as the type figure of the adult specimen of *S. raphanus* (Parker and Jones, 1865) exhibits an aperture which is about the same size as that of *S. costata* Schlumberger (1883); the shorter specimen figured by Parker and Jones possesses an aperture fully twice as large as that of the larger specimen. Considering the variability observed in the specimens from Tahiti and their similarity to both of the species discussed, it seems both desirable and necessary to consider the two synonymous; hence the prior form, *S. raphanus* (Parker and Jones) is the genotype of *Siphocerina* as previously indicated by Cushman (1913, 1927) and by Galloway (1933).

The remaining question concerns the matter of chamber arrangement for the genus. As an approach to this matter, one may examine the type figure wherein there is a biserial to uniserial chamber arrangement (Parker and Jones, 1865). In order to ascertain the amount of dimorphic variation in the species, specimens of *S. raphanus* were obtained for examination

EXPLANATION OF PLATE 4

Micrometula hyalostriata Nyholm

FIGS.		PAGE
1. Total slide (no section). es - striated envelope, nu - nucleus. ca 100 X.	.....	15
2. Photo of a living specimen. d - detritus, at the apical aperture, e - envelope, ap - basal aperture, d - detritus. ca 110 X.	.....	15
3. A living specimen with the apical plasma contracted. e - envelope, cp - cytoplasm, d - detritus at the basal aperture. ca 100 X.	.....	15
4. Preserved specimen. See fig. 3. ca 100 X.	.....	15
5. Longitudinal section. No inclusions of detritus in the plasma, nu - nucleus. ca 110 X.	.....	15
6. Specimen with insertions. ca 100 X.	.....	15
7. Specimen with insertions. ca 100 X.	.....	15
8. See fig. 5. ca 150 X.	.....	15
9. Section through the basal part of <i>Micrometula</i> . e - envelope, ap - aperture. ca 500 X.	.....	15
10. Longitudinal section of a sublimate-preserved specimen. e - envelope, nu - nucleus. ca 500 X.	.....	15

from the U. S. National Museum, through the courtesy of A. R. Loeblich. Examination of these specimens indicated again a biserial to uniserial arrangement. Inasmuch as the type area of *S. costata* was given by Schlumberger as Tahiti and New Caledonia, material was also obtained from Tahiti and examined. Some of the Tahitian specimens were found to be triserial to uniserial in chamber arrangement and others were biserial to uniserial. Among the Tahitian specimens this seems to be a clear-cut case of dimorphism. The specimen figured on plate 5, fig. 1 is one of the triserial to uniserial specimens.

It seems reasonable to define the genus *Siphogenerina* as a typical dimorphic foraminifer in which the test is free, elongate, subcylindrical; triserial to uniserial to biserial to uniserial in the microspheric form, biserial to uniserial in the megaspheric form; wall calcareous, hyaline, finely perforate, variously ornamented; aperture terminal, round or oval, with a raised rim or short neck and phialine lip; interior with mostly complete toothplates extending to the previous apertures.

In 1945 Mathews established the genus *Rectuvigerina* for those species of *Siphogenerina* which are triserial to uniserial in chamber arrangement and in which there is no indication of a biserial to uniserial character. He restricted *Siphogenerina* to the biserial to uniserial species. Such a division certainly does not controvert the stated concept of the genus *Siphogenerina* by Schlumberger in 1882 and 1883; however, it does ignore the dimorphic character of the genus. As indicated in the previous paper (Bandy and Burnside, 1951) *S. multicostata* Cushman and Jarvis, the type of *Rectuvigerina* is triserial to uniserial in both micro- and megaspheric forms. Hence, *Rectuvigerina* Mathews does embrace a restricted morphological group and may be recognized.

In summation, *Siphogenerina costata* Schlumberger (1883) is a synonym of *S. raphanus* (Parker and Jones) (1865). It is always possible to find forms assignable to the second species but only very rarely does one encounter a variant which would fit the type figure of Schlumberger, and then, so far as is known by the writer, it is always associated with a population assignable to the other form. The genotype is

then *Siphogenerina raphanus* (Parker and Jones). Plate 5, fig. 1 illustrates a specimen of *S. raphanus* which is triserial to uniserial in chamber arrangement — many of the members of the same population had a fairly well-developed biserial to uniserial chamber arrangement — hence, it is mandatory to encompass both forms in any definition of the genus. Those species which are exclusively triserial to uniserial in chamber arrangement fall within the definition of *Rectuvigerina* Mathews (1945).

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49. MIOCENE FORAMINIFERA FROM ERBEN BANK

ORVILLE L. BANDY

University of Southern California

The unique foraminiferal assemblage discussed in this paper was collected from Erben Bank by A. J. Carsola and R. S. Dietz of the U. S. Naval Electronics Laboratory, San Diego, Calif. The bank is located about 800 miles west of San Diego, California, at 32° 24' N. Lat. and 127° 47' W. Long. In an unpublished

manuscript, Carsola and Dietz describe Erben Bank as a truncated cone which rises from the floor of the ocean at a depth of about 2300 fathoms to within about 400 fathoms of sea level. The sample containing the fossil foraminifera is described as a manganese-coated breccia consisting of basalt fragments cemented

by limy detritus. The fauna occurred in the limy detritus and was found to be almost completely foreign to known fossil assemblages from California. F. B. Phleger and Miss Frances Parker of the Scripps Institution of Oceanography examined the fauna and classified it as post-Cretaceous and pre-Pleistocene and most likely about mid-Tertiary. Phleger and Parker kindly allowed the author to make a systematic analysis of the fauna and table 1 represents the results of this investigation.

The preservation of the fauna is poor and the identifications were very difficult. In table 1 is given (1) a list of the species (2) known geographic localities and (3) geologic ranges. It is at once apparent that the fauna is about middle Cenozoic in age and that nearly all of the species are foreign to California. Most of the affinities are with late Oligocene and Miocene faunas of Venezuela. To be sure, two of the species are identical to those reported by Leroy from the East Indies and one species, *Cassidulina cuneata*, has only been reported previously from the Miocene of New Zealand. With reference to the Venezuelan species, one should note that the Oligocene occurrences are correlated by Renz with Zemorian, Saucesian and lower Relizian stages of California. *Valvulinaria inaequalis* (d'Orbigny) and similar forms are known in California from Recent to Lower Miocene. Two of the species listed, *Högglundina elegans* and *Ceratobulimina pacifica* are very similar to the figured specimens of Leroy from the Miocene-Pliocene strata of the East Indies (Leroy, 1941).

From the information available, it would seem logical to assign a Miocene age to the fauna as is suggested by the tabular presentation in table 1. It is worthy of mention to note that the species of *Robulus* are unreported; however, they bear general similarity to species such as *Robulus hedbergi* Cushman and Renz and *R. nuttalli* Cushman and Renz (1948, Geol. Soc. America, Memoir 32, pl. 3, figs. 10 and 12 respectively) from the Oligocene (equals L. Miocene of California) of Venezuela. There were poorly preserved specimens and fragments of a few other species which were omitted from the list in table 1.

SYSTEMATICS

The specimens figured and described in this section are deposited in the Paleontological Collection of the University of Southern California, Los Angeles, Calif. The remainder of the fauna is deposited in the Marine Foraminifera Laboratory, Scripps Institution of Oceanography, LaJolla, California. The preservation was very poor in many cases and it was necessary to use staining techniques to bring out the structures. Methylene blue was found to be the best stain of the several tried. Three species are described and figured; the first species is an interesting cuneate *Cassidulina* only reported

previously in New Zealand, the other two species were found to be undescribed.

Cassidulina cuneata Finlay Plate 5, figures 2a-c

Cassidulina cuneata FINLAY, 1940, Roy. Soc. New Zealand, Trans. Proc., vol. 69, pt. 1, p. 456, pl. 63, figs. 62-66 (holotype, fig. 66); Upper Oligocene (?), Miocene common, New Zealand.

Test cuneate, irregularly oval from top view; back broadly rounded; about four pairs of chambers in the last whorl; sutures flush; surface smooth, wall finely perforate; aperture comparatively large, slightly curved and generally aligned about forty-five degrees to the plane of coiling as observed in the front view. Diameter, 0.27 mm.; thickness, 0.24 mm.

Hypotype — U. S. C. No. 989.

Finlay shows several top views in his original paper, which do not exhibit the cuneate character of the species, however, it shows up well in the back view of the type figure.

Robulus dispansus Bandy, n. sp. Plate 5, figures 3a, b

Test planispiral, close-coiled in the early portion, tending to be evolute in the last whorl; edge with a distinct broad flange which is usually ragged; chambers about 8-10 in the final whorl, increasing very gradually in size as added, later ones becoming slightly inflated; sutures distinct, evenly curved, flush in the early part, slightly depressed in the later portion, wall smooth, finely perforate; aperture radiate, at the outer edge of the last septal face, with an extension downward. Diameter of holotype, 0.66 mm.; thickness, 0.18 mm.

Holotype — U. S. C. No. 990.

Robulus erbenensis Bandy, n. sp. Plate 5, figures 4a-c

Test planispiral, compressed, close-coiled in the early portion, tending to uncoil in the later part; periphery lobate and characterized by the presence of long acicular spines which are located near the forward portion of the backs of the chambers; chambers 6-8 in number, distinct, slightly inflated if at all in the early portion of the test, becoming somewhat inflated in the later part of the test; sutures distinct and curved, flush in the early portion becoming depressed in the later part; wall smooth, finely perforate, only ornamentation being the acicular spines on the edge; aperture at the outer edge of the last septal face, radiate with a noticeable extension down toward the septal face. Maximum diameter of holotype, 0.74 mm.; thickness, 0.24 mm.

This species is similar to *Hantkenina* in ornamentation, however, the radiate aperture clearly categorizes it with *Robulus*. Fig. 4c is the view of a well-preserved aperture in a paratype.

Holotype — U. S. C. No. 991.

Table 1. — Stratigraphic and Geographic Ranges of
the Erben Bank Fossil Foraminifera

SPECIES AND REFERENCES

	Geographic Range				Geologic Range			
	N. Zealand	E. Indies	Venezuela	Trinidad	Recent	Pleistocene	Pliocene	U. Miocene
<i>Cassidulina cuneata</i> Finlay	x						x	
Finlay, H. J., Roy. Soc. New Zealand, Trans. Proc., vol. 69, pt. 1, p. 456, 1940; this paper, pl. 5, figure 2.							x	
* <i>Ceratobulimina pacifica</i> Cushman and Harris	x				x	x	x	x
Leroy, L. W., Colorado School of Mines Quarterly, vol. 36, no. 1, pl. 97, figs. 34, 35, 1941.								
† <i>Globigerina triloba</i> Reuss					x	x	x	x
Reuss, A. E., K. Akad. Wiss. Wien., Math.-Nat. Cl., Denkschr., Bd. 1, p. 374, pl. 47, fig. 11, 1850.							x	
<i>Globigerina venezuelana</i> Hedberg		x					x	x
Hedberg, H. D., Jour. Paleontology, vol. 11, no. 8, p. 681, pl. 92, fig. 7, 1937.							x	x
‡* <i>Höglundina elegans</i> (d'Orbigny)					x	x	x	x
Leroy, L. W., loc. cit., pl. 97, figs. 13-15, 1941.								
<i>Lingulina</i> sp.								
<i>Robulus dispansus</i> Bandy								
This paper, pl. 5, figure 3.								
<i>Robulus erbenensis</i> Bandy								
This paper, pl. 5, figure 4.								
<i>Uvigerina auberiana</i> var. <i>attenuata</i> Cushman and Renz		x	x				x	x
Cushman, J. A. and Renz, H. H., Cushman Lab. Foram. Res., Contr., vol. 17, p. 21, pl. 3, fig. 17, 1941.							x	x
<i>Uvigerina carapitana</i> Hedberg		x	x				x	x
Hedberg, H. D., loc. cit., p. 677, pl. 91, fig. 20, 1937.								
†* <i>Valvularia cf. inequalis</i> d'Orbigny	x				x	x	x	x
Cushman, J. A., Bull. Scripps Inst. Oceanography, vol. 1, no. 10, p. 161, pl. 4, figs. 9, 10, 1927.								
<i>Valvularia inequalis</i> var. <i>lobata</i> Cushman and Renz		x			x	x	x	x
Cushman, J. A. and Renz, H. H., loc. cit., p. 23, pl. 3, fig. 24, 1941.								

* Especially similar to hypotype figured in indicated reference.

† Cosmopolitan — Geographic Range.

4 4 4 6 7 3 Total
(8)

Figs.

EXPLANATION OF PLATE 5

PAGE

1. *Siphogenerina raphanus* (Parker and Jones). Side view. $\times 65$. Recent, Tahiti. 18
2. *Cassidulina cuneata* Finlay. 2a, Back view; 2b, Apertural view. 2c, side view. $\times 120$. Miocene, Erben Bank. 19
3. *Robulus dispansus* Bandy, n. sp. 3a, Apertural view; 3b, side view; $\times 50$. Miocene, Erben Bank. 19
4. *Robulus erbenensis* Bandy, n. sp. 4a, Side view; 4b, apertural view; 4c, view of aperture of a paratype $\times 55$. Miocene, Erben Bank. 19
5. *Elphidium oregonense* Cushman and Grant, $\times 22\frac{1}{2}$. Amstelian, Lower Pleistocene, Netherlands. 22
6. Faunal assemblage with *Elphidium oregonense* Cushman and Grant from a boring in the IJssel Sea, depth 316 m. $\times 10$. 22
7. *Flabellinella zitteliana* (Egger), Maestrichtian, Starzmühl near Teisendorf, Bavaria. $\times 20$. 7a, micro-spheric form; 7b, megaspheric form; 7c, tribrachiate (pathological) form. 22
8. *Micrometula hyalostriata* Nyholm, n. gen., n. sp. Nat. size. 0.7 - 1.2 mm. Photo: Ember and Spandau. 24



1



2a



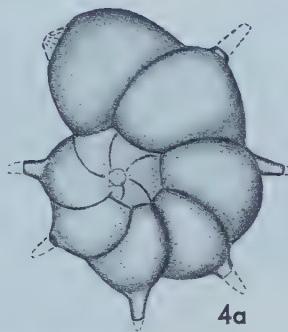
2b



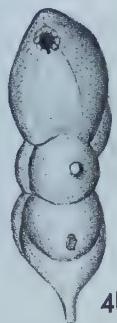
2c



3a



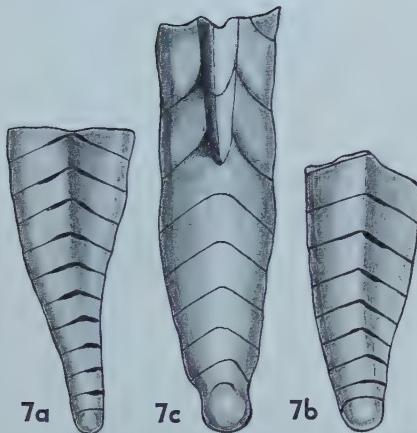
4a



4b



3b



7a



7c



7b



8



6

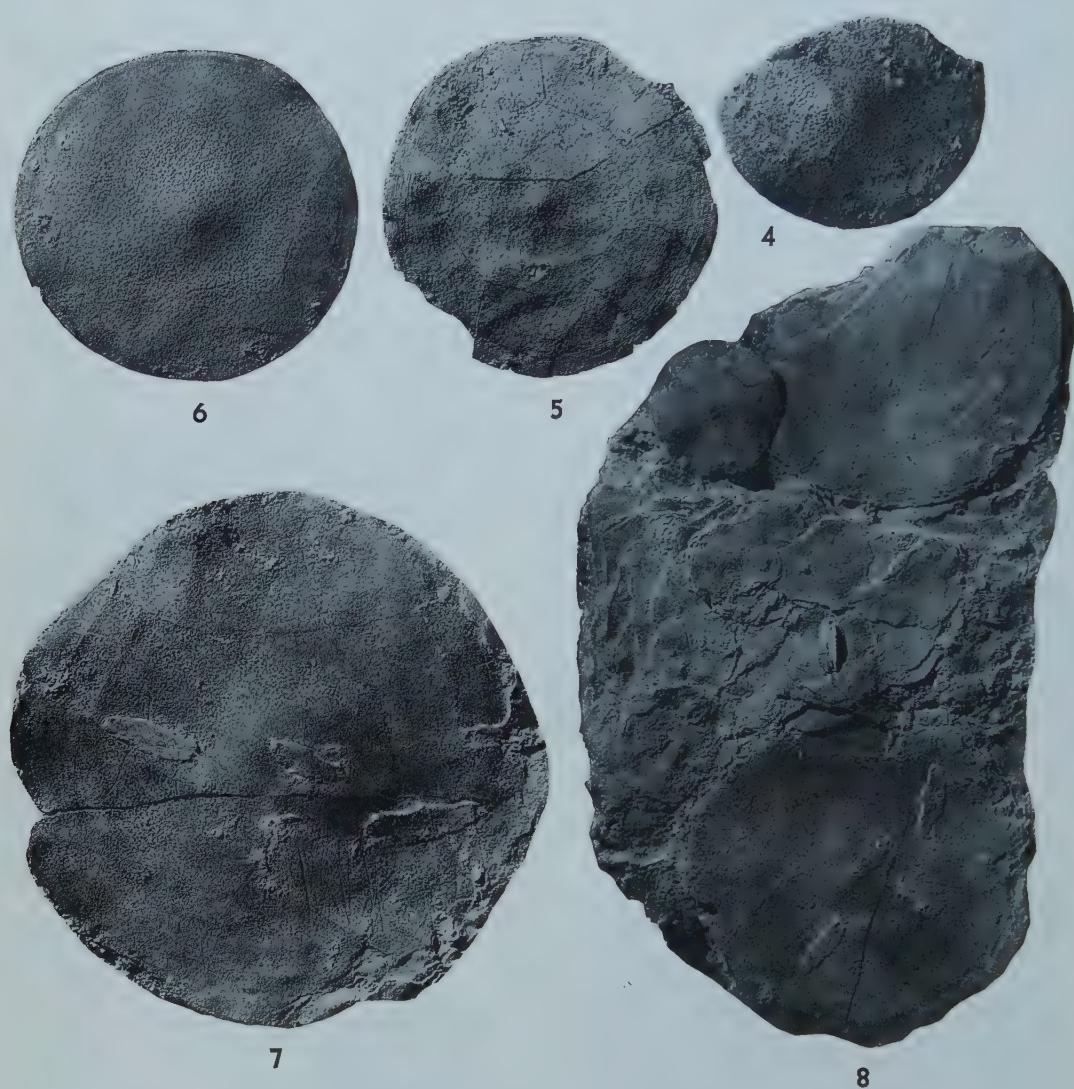


5

Bandy: Genotype of *Siphogenerina*

Bandy: Miocene Foraminifera from Erben Bank

van Voorthuysen: *Elphidium oregonense* Cushman and GrantHagn: *Flabellinella zitteliana* (Egger)Nyholm: *Micrometula*



Crespin: *Lepidocyclina* from Australia

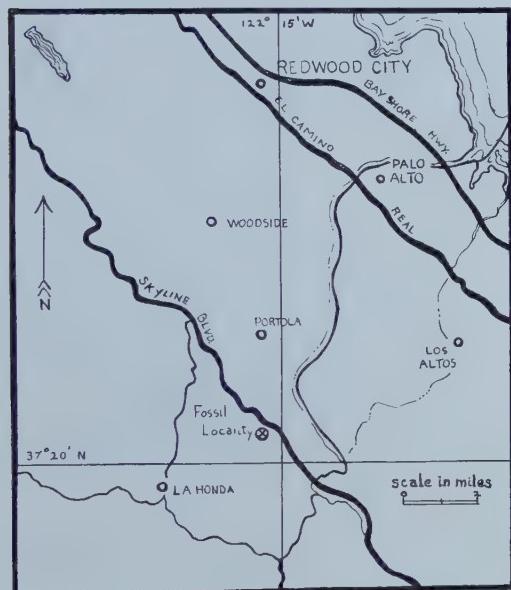
50. AN OCCURRENCE OF MIOGYPSSINA IN CALIFORNIA

JOSEPH J. GRAHAM
Stanford University

and

C. W. DROOGER
University of Utrecht

While engaged in stratigraphic exploration in the Halfmoon Bay quadrangle, south of San Francisco, Robert N. Hacker, geologist for the Union Oil Company of California, discovered a series of miogypsinid specimens in a calcareous grit exposed near the axis of a synclinal fold in the vicinity of Portola, San Mateo County (Text Fig. 1). Apparently this is the first record of the genus *Miogypsina* in California.



Text Fig. 1. Outline map showing the Portola-La Honda district, San Mateo County, California, where an occurrence of *Miogypsina* (*Miolepidocyclina*) *ecuadorensis* Tan has been reported.

Thin section study indicates the specimens are *Miogypsina* (*Miolepidocyclina*) *ecuadorensis* Tan, a species described from late Middle to early Upper Oligocene reefal beds at San Pedro, near Valdivia, southwest Ecuador (Cushman and Stainforth, 1951). The Californian individuals are poorly preserved, with little or

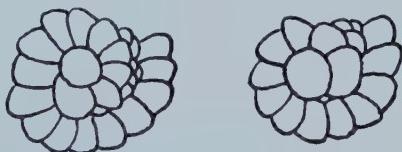
no external ornamentation. They occur in great abundance in a coquina-like brown or buff colored limonitic-stained grit that appears to have been derived from a granitic distributive province. No other fossils were observed in the grit. It is interesting to note that *M. ecuadorensis* is also abundant and poorly preserved at its type locality and likewise occurs in a ferruginous grit (Barker, 1932). Unlike the Californian occurrence, however, the Ecuadorean specimens are associated with *Amphistegina* spp. and *Lepidocyclus* (*Nephrolepidina*) sp. (Stainforth, 1948).

The Californian miogypsinids appear to be a little higher developed morphologically than the Ecuadorean ones and may indicate a slightly younger age than that designated for the San Pedro specimens. If they are Upper Oligocene as their morphogenetic history indicates, then the beds containing these fossils, mapped as Upper Miocene in the Santa Cruz Folio (1909) and as Lower Miocene on the Geologic Map of California (1938 edition) will have to be redated.

The Ecuadorean and Californian localities are the most widely separated occurrences of *M. ecuadorensis* known so far in the southern and northern hemispheres. The species has also been observed in the Middle Oligocene San Sebastian formation of Puerto Rico.

Miogypsina (*Miolepidocyclina*) *ecuadorensis* Tan
Text figure 2

Miogypsina aff. *M. panamensis* (CUSHMAN), BARKER, 1932, Geol. Mag., vol. 69, p. 280, pl. 16, fig. 7.



Text Fig. 2. The embryonic-nepionic stage in two specimens of *Miogypsina* (*Miolepidocyclina*) *ecuadorensis* Tan from California, $\times 30$.

EXPLANATION OF PLATE 6

FIGS.

	PAGE
1. <i>Lepidocyclina</i> (<i>Eulepidina</i>) <i>badjirraensis</i> Crespin, n. sp. Microspheric form. \times circ, nat. size	29
2. <i>L. (E.)</i> <i>badjirraensis</i> Crespin, n. sp. Megalospheric form. \times circ. 2	29
3. <i>L. (E.)</i> <i>manduensis</i> Crespin, n. sp. Megalospheric form. \times 2.5	30
4. <i>L. (E.)</i> <i>manduensis</i> Crespin, n. sp. Microspheric form. \times circ. 2	30
5. <i>L. (E.)</i> <i>badjirraensis</i> Crespin, n. sp. Megalospheric and microspheric forms on surface of limestone. \times 2/3 nat. size	29

Miolepidocyclina ecuadorensis TAN SIN HOK, 1936, De Ingenieur in Ned. Indië, IV, De Mijningenieur, 3e jaarg., p. 59.

Heterosteginoides panamensis HANZAWA (not CUSHMAN), 1947, Jour. Paleont., vol. 21, p. 260, pl. 41, figs. 1-13.

Description.—Test about rounded in outline, irregularly biconvex to planoconvex, relatively thick, greatest thickness near the center. Diameter 1-2 mm, thickness 0.5-1 mm. Surface evenly covered with pustules, varying in diameter between 45 μ and 140 μ .

In median sections (25 observations) of megalospheric specimens the embryonic-nepionic stage is seen to be situated near the center of the test. The diameter of the protoconch ranges from 130 μ to 240 μ (average 170 μ); the slightly kidney-shaped deutoerconch is of about equal larger dimension. From the large first principal auxiliary chamber a protoconchal and a deutoerconchal nepionic spiral have been developed, consisting respectively of 16-10 (average 12.28) and 0-5 (average 1.68) chambers. In 6 out of 25 sectioned specimens a very small second principal auxiliary chamber, without further spiral chambers, was ascertained. Equatorial chambers usually irregularly arcuate to ogival in shape; larger dimensions 160 x 185 μ . No microspheric individuals were encountered.

In transverse sections (2 observations) the median layer appeared to be about 100 μ high, with the embryonic chambers distinctly protruding. Lateral chambers arranged in rather regular, dome-shaped layers (height about 40 μ), often in tiers; about 8 chambers in vertical succession from the median layer to the surface at the more convex side of the test.

Remarks.—This assemblage of *M. ecuadorensis* differs from that of the type locality San Pedro, Ecuador, border-line between Middle and Upper Oligocene, by a slightly lower average number of spiral chambers in the protoconchal nepionic spiral, and by a slightly higher average number in the deutoerconchal nepionic

spiral. Moreover in the Ecuadorean material no individuals, possessing a second principal auxiliary chamber, were observed (compare: Drooger, 1952, Study of American Miogypsinidae, in press).

From these features it appears that the Californian assemblage is somewhat higher developed morphologically than the Ecuadorean one, tending towards *M. burdigalensis* (Gümbel) from S. W. France. The latter species, however, is significantly different from both occurrences of *M. ecuadorensis* in the western hemisphere.

Occurrence.—Calcareous grit outcrop on C. H. Williams Ranch, central part of N. ½ Sec. 1, T. 7 S., R. 4 W., Santa Cruz Quadrangle, California (Santa Cruz Folio, 1909), or about 1.45 miles S. 3° E. of benchmark 1790 near Portola, San Mateo County, Halfmoon Bay Quadrangle, Grid Zone "G," War Department, Corps of Engineers, U. S. Army, 1943.

Hypotypes.—Geological Institute of the State University of Utrecht, Netherlands, D 33840 - 33845 (including specimens shown in Fig. 2). Additional specimens in Micropaleontological Collection at Stanford University.

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51. ELPHIDIUM OREGONENSE CUSHMAN AND GRANT, A POSSIBLE MARKER FOR THE AMSTELIAN (LOWER PLEISTOCENE) IN NORTH AMERICA AND NORTHWESTERN EUROPE

J. H. VAN VOORTUYSEN

Netherlands Geological Survey, Haarlem

In a boring recently drilled in the center of the former Zuyder Zee (Ijssel Lake) in the vicinity of the boring Harderwijk (see Van Voorthuysen, 1948, fig. 2) quite a number of large-sized specimens of *Elphidium oregonense* Cushman and Grant with the species men-

tioned below were found at a depth of 316 meters in Lower Pleistocene (Amstelian) beds. Up to now examination of the washed residue passing through the 1 mm sieve had been neglected, and, therefore, these large *Elphidiums* escaped attention. (See Plate 5, fig.

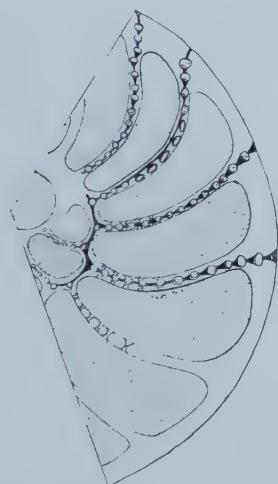
5). The following assemblage of species was found in the boring: *Elphidium oregonense* Cushman and Grant (3%); *Elphidiella* sp. cf. *E. arctica* (Parker and Jones) (57%) nearly related to *E. hawaii* (Cushman and Grant) and *E. nitida* Cushman (see Cushman, 1941); *Quinqueloculina seminulum* (Linne) (27%); others non-identified species of *Elphidium* (5%); *Streblus beccarii* (Linne) (3%); *Eponides frigidus* (Cushman) (1%), and a few rare other species. (See Plate 5, fig. 6).

This rather uncommon quantitative distribution-pattern indicates a peculiar type of ecological environment: the low percentage of *Streblus beccarii* and the high amount of *Quinqueloculina seminulum* does not wholly fit into the normal scheme of Pleistocene littoral-brackish water percentage-distribution in the North Sea Basin.

It seems that we deal here with a somewhat deeper sea environment, because *Streblus beccarii* shows its peak of maximum percentage in the littoral-brackish-

So far there is not very much known about the stratigraphical distribution of *Elphidium oregonense* Cushman and Grant in North America and Northwestern Europe. It would, however, not be surprising if this large and striking species would make an excellent marker for long range correlation between North American and N.W. Europe during the oldest Pleistocene time.

In 1941 Cushman allocated *Elphidium oregonense* to *Elphidiella* (see also Bandy, 1950). Wax-preparations made for the study of the canal system, however, indicate that our form possesses a single row of openings narrowly beginning and broadly ending (see Text fig. 1). In this connection it is worthwhile to refer to Hofker's excellent studies on the canal system of *Elphidium* (?) *craticulatum* (Fichtel and Moll) where he considers the forking canals (see: Hofker, 1927, Plate 26, fig. 10) as microspheric and the single row openings as megalospheric forms. Since our *Elphidium oregonense* specimens do not show forking canals they are considered to belong to *Elphidium*.



Text Fig. 1. Wax preparation of *Elphidium oregonense* showing the single row of funnel-shaped pores (sutural canals)

water environment, and *Quinqueloculina seminulum* shows the same peak between depths of 12 to 44 meters (2.9 to 13.6% according to Parker, 1948). Most probably the faunal assemblage indicates a depth of around 40 meters (deeper littoral zone). There are other Lower Pleistocene (Amstelian) sediments in the Netherlands which have accumulated in deeper basins (see: Van Voorthuysen, 1950) although with a different faunal assemblage.

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52. A TRIBRACHIATE FLABELLINELLA ZITTELIANA (EGGER)
 FROM THE UPPER CRETACEOUS OF BAVARIA,
 WITH NOTES ON THE GENUS TRIBRACHIA SCHUBERT, 1912

HERBERT HAGN

Munich, Bavaria

J. G. Egger (1899) described from the Maestrichtian Gerhardsreuter beds of Starzmühl near Teisendorf (Bavarian Alps) under the name of *Frondicularia zitteliana* a species, which on account of its *Vaginulina*-like initial part, especially in the microspheric generation, should be allocated to *Flabellinella* Schubert, 1912 (see: Cushman, 1948, pl. 20, fig. 17). The younger chambers of this form are equitant and inverted V-form in shape. This species is rather frequent in the Gerhardsreuter beds. Besides the typical individuals are degenerated forms with a tribrachiate test. This feature is apparently pathological, and can frequently be observed among the highly variable and polymorphous Lagenidae. Since such monstrosities were sometimes given generic status (f. i. *Tribrachia* Schubert, 1912) a discussion of their validity is herewith given. The typical form is described, as follows:

Flabellinella zitteliana (Egger)

Plate 5, figures 7a, b

Frondicularia zitteliana EGGER, 1899, K. Bayer Akad. Wiss. München, Abhandl., II. Classe, vol. 21, 1. Abt., p. 91, pl. 13, figs. 26-29.

Description.—Test longiform, slender in the initial part of the test but increasing in width towards the younger chambers, laterally compressed; broader sides of the test slightly depressed in the median line; margin rounded-angular. Spherical initial chamber followed by a few narrow *Vaginulina*-like chambers in oblique position and about twice as broad than high, followed by equitant *Frondicularia*-chambers, also narrow but slightly and regularly sloping laterally. Sutures distinct, slightly raised, consisting of hyaline shell substance. Aperture could not be examined.

Microspheric forms with a small initial chamber (0.2 mm) and 4-6 *Vaginulina*-like chambers; test narrow and slender at initial end increasing in size as *Frondicularia*-like chambers are added. Megaspheric forms with larger proloculus (0.29 mm) and only 2-3 *Vaginulina*-like chambers; regularly increasing in width.

Occurrence.—Gerhardsreuter Beds (Maestrichtian) at Starzmühl near Teisendorf (southern Bavaria); according to Egger (1899) also at the type locality Gerhardsreut, near Höpfing, and near Pattenau.

Discussion.—Besides normal individuals there are tribrachiate tests which are regarded as abnormal. The degenerated test is much larger than the normal one and assumes in its younger part a typical tribrachiate form (see Plate 5, fig. 7c) with a relatively large (0.42 mm) and irregularly formed proloculus. Appar-

ently the few initial *Vaginulina*-like chambers grew pathologically together with the proloculus. The median depression on the broad sides of the test, always observed in normal individuals, occurs on one side only (see Plate 5, fig. 7c). Such differences are, however, insufficient for separating pathological specimens from co-existent normally built individuals of *Flabellinella zitteliana* (Egger). Thalmann (1949) has warned strongly against such a procedure.

Tribrachiate degenerations in Lagenidae are occasionally observed. They are known to occur in the following genera: *Frondicularia* Defrance, 1824, *Palmula* Lea, 1833, *Citharinella* Marie, 1938, and the above mentioned *Flabellinella*. To unite such tribrachiate-degenerated forms in the genus *Tribrachia* Schubert, 1912, as recently advocated by Bartenstein and Brand (1950) seems highly inadvisable. This should, therefore, be avoided. (See: Thalmann, 1949, p. 368).

Schubert (1912, p. 183) proposed the genus *Tribrachia* for such "three-armed" *Frondicularias* but did not designate a genotype. Loeblich and Tappan (1950, p. 16, pl. 1, fig. 39a, b) proposed, therefore, *Tribrachia inelegans* Loeblich and Tappan from the Callovian Rierdon formation, U. S. A., as the genotype. Although these authors state that occasional tribrachiate individuals are also found in *Citharinella*, *Palmula*, and *Frondicularia*, they believe (1950, p. 15) that: "the occurrence of *Tribrachia* not associated with any of these genera establishes the validity of the genus." Furthermore they regard *Frondicularia amoena* Reuss (Senonian, Galicia), and *Frondicularia tricarinata* d'Orbigny (White Chalk, Paris Basin) as species of *Tribrachia*. Bartenstein and Brand (1950) also consider *Tribrachia* as a valid genus, and describe four new species, *T. reussi*, *T. schuberti*, *T. westfalica*, and *T. subcretacea* from the Cretaceous of northern Germany. It is interesting to note the relatively small number of holotypes and paratypes on which these authors erected their four species. In my opinion they are pathological forms and should be regarded as *nomina caduca*.

Bartenstein (1950) demonstrated the difficulties in generic allocation of some Lagenidæ, and pointed out that in the Chattian of Westphalia there are some well-defined genera which seem to intergrade. In their study of the Molasse sediments (Rupelian to Helvetian) of Southern Bavaria Hagn and Hözl (1950) found the form-constancy of the Lagenidae to be rather variable, at least for the Tertiary. They discovered also that this family and its genera are of

restricted value as stratigraphic markers, in contrast to the representatives of the Heterohelicidae, especially of the genus *Plectofrondicularia* Liebus, 1903, which yielded several excellent markers for the subdivision of the Bavarian Molasse beds.

It should also be pointed out that the genus *Tribrachia* was not figured by Schubert, nor was a genotype ever designated. It should, therefore, be regarded as a *nomen nudum*. It seems, moreover, that even Schubert took such tribrachiate forms as examples of pathological degeneration, while, on the other hand, mixed forms, like his *Flabellinella* were considered important in phylogenetical evolution. He writes (Schubert, 1912, p. 183): "Die oberkretazischen rhabdогonienartigen Formen, die "drei-schenkligen Frondicularien," für welche sich unter teilweiser Benützung des Dettmer'schen Vorschlages etwa die Bezeichnung *Tribrachia* verwenden liesse, entstanden dagegen, indem bei abnormer Plasmazunahme die Sarcode nach drei, statt wie sonst bei den Frondicularien nach zwei Richtungen abfloss." In his posthumous paper Schubert (1921, p. 175) expresses himself somewhat more positive: "Zu rhabdогonienartigen Formen (*Tribrachia* Schubert, 1912) entwickeln sich manche oberkretazische Frondicularien."

Since there is no further development in *Tribrachia* from a phylogenetical point of view, there remains only a physiological explanation. Schubert believed that the morphological feature of *Tribrachia* was caused by change in the amount of plasma or in the turgor of the plasma or by amalgamation of iso- and agametes, as has occasionally taken place in *Nummulites*.

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53. GLOBIGERINOITA AND GLOBIGERINATHEKA, NEW GENERA FROM THE TERTIARY OF TRINIDAD, B. W. I.

P. BRONNIMANN
Trinidad Leaseholds Ltd., Pointe-a-Pierre

Certain genetically only loosely related Globigerinas have in their mature stage subglobular or globular tests. These adult tests are generally characterized by a multiple aperture. From a brief survey of the structure of adequately figured Globigerinas (Ellis and Messina, 1940) it appears that subglobular tests are formed by:

a) a simple trochoidal spiral, without enveloping chambers or supplementary chamberlike growths. The ultimate chamber can be predominant in size [e. g. *Globigerina altispira* Cushman and Jarvis 1936 (Mio-

cene, Jamaica)], not yet described Upper Cretaceous Globigerinas from Trinidad, related to the group of *G. rugosa* Plummer, *Globigerinoides mexicana* (Cushman) 1925 (Upper Eocene, Mexico), *Globigerinoides conglobata* (H. B. Brady) as described by Cushman and Stainforth (1945, p. 68, pl. 13, fig. 6) from the Upper Oligocene Cipero formation of Trinidad, *Globigerinoides cyclostoma* (Galloway and Wissler) 1927 (Pleistocene, California), *Globigerinoides semiinvolutus* Keijzer 1945 (Upper Eocene, Cuba), etc.],

b) the rapid enlargement and the enveloping ten-

dency of the few last formed chambers or of the ultimate chamber [(e. g. *Orbulina suturalis* Brönnimann 1951 (= *Candorbolina universa* Jedlitschka 1934 = *Candeina triloba* Jedlitschka 1934), *O. bilobata* (d'Orbigny) 1846, *O. universa* d'Orbigny 1839, the latter, with an almost spherical test, representing the extreme possible case)],

c) the development of additional chamber-like growths, across the umbilical depression or along the sutural grooves, thus compensating for major inequalities of the test (e. g. *Globigerinata naparimaensis* Brönnimann 1951),

d) the combination of embracing chambers and of supplementary chamberlike growths (e. g. *Globigerinatella insueta* Cushman and Stainforth 1945).

With the exception of some simple trochoidal species of group a, the above mentioned four basic groups of subglobular tests contain highly differentiated phylogenetic end forms probably remarkably well adapted to planktonic life (Kemna 1903). The new genera *Globigerinoita* and *Globigerinatheka* belong with the third group c, characterized by additional chamberlike growths without enveloping tendency of the *Globigerina* chambers in the course of the ontogeny. For the time being, generic rank is given to these phylogenetic end forms, although we are well aware that a future revision of the Globigerinidae might lead to a different taxonomic interpretation.

Genus *Globigerinoita* Brönnimann, n. gen.

Genotype.—*Globigerinoita morugaensis* n. sp., Lengua formation, Basal Miocene, Moruga area, Trinidad, B. W. I.

Diagnosis.—Test almost spherical, in the adult composed of a three chambered *Globigerinoides* and two supplementary chamberlike growths. Main aperture, large, arcuate, umbilical, at the intersection of the sutures of the three lastformed chambers. Single, additional *Globigerinoides* aperture small, semicircular, approximately opposite the main aperture between the two last formed chambers and the closely coiled initial portion of test. Supplementary "chambers" or chamberlike growths cover the main aperture, and in grown up individuals also the *Globigerinoides* aperture. The umbilical growth forms in the last ontogenetic stage occasionally small additional "chamberlets," separated from the main growth by fairly deep incisions. Aperture in the adult multiple, consisting of up to 12

small, rounded openings situated at the sutural grooves. In general, there are 3 openings from the umbilical growth and 2 to 3 from the growth across the *Globigerinoita* aperture. Where additional "chamberlets" are issued from the umbilical growth, the number of openings is further augmented by 3 per "chamberlet."

Remarks.—*Globigerinoita* is monotypic, and differs from all other genera with supplementary chamberlike growth by its distinct *Globigerinoides* structure. The test, immediately prior to the formation of supplementary growths, is in

Globigerinata: trochoidal *Globigerina*, with single aperture,

Globigerinatheka: trochoidal *Globigerina*, very probably with single aperture,

Globigerinatella: "*Globigerina*" with enveloping tendency, and multiple apertures.

In addition, also the structure of the supplementary "chambers" is different in the various genera. *Globigerinata* (1951, p. 18) and likewise the primitive *Globigerinatella* type described under a) (1950, p. 81) have only one single, usually branching supplementary "chamber" with numerous minute semicircular openings not restricted to the sutural grooves, whereas *Globigerinoita* possesses in the well developed adult exactly two chamberlike growths. Occasionally, additional "chamberlets" are formed, each with at the most 3 semicircular openings situated at the sutural grooves. The Upper Eocene *Globigerinatheka* differs from *Globigerinoita* by a composite system of supplementary chambers, consisting of a large inflated growth across the umbilicus and of 3 small and low chamberlike growths.

Occurrence.—Miocene, Trinidad, B. W. I.

Globigerinoita morugaensis Brönnimann, n. sp.

Text figures 1, 2

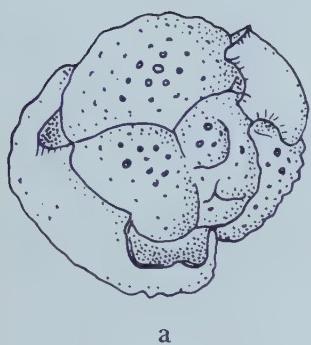
Holotype.—*Globigerinoita morugaensis* Brönnimann, T. L. L. Cat. No. 3514, Text figure 1, a, b, c, 75×. *Globorotalia menardii* Zone, Lengua formation, Basal Miocene, Moruga area, Trinidad, B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, U. S. A.

Description.—The trochoidal test is three chambered in the adult. The small initial portion is indistinct, coarsely cancellated, and it is almost impossible to rec-

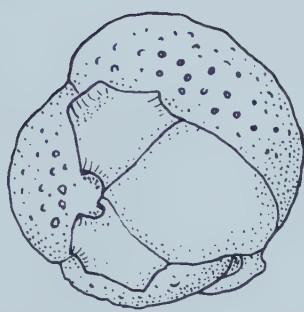
TEXT FIGS.

EXPLANATION OF TEXT FIGURE 2

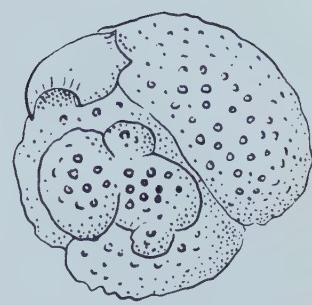
- 2 a-h *Globigerinoita morugaensis* Brönnimann, Lengua formation, Basal Miocene, Moruga area, Trinidad, B. W. I. T. L. L. Cat. No. 3514, All appr. 75×. Various individuals. a, b, the same specimen, with spreading umbilical growth showing clearly the 3 additional "chamberlets," each with 3 small openings. d, e, the same specimen, *Globigerinoides* aperture in the corner between 2 last formed chambers and the initial spiral, not yet covered with supplementary growth. f, g, h, 3 specimens, with broken up umbilical growth (a, b) and with broken up end chamber (c). The rest of the umbilical growth still present in front of the main aperture.



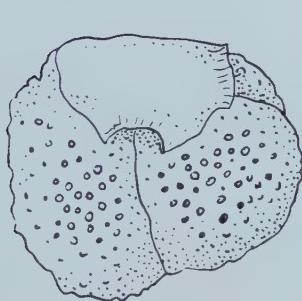
a



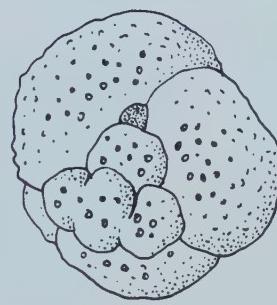
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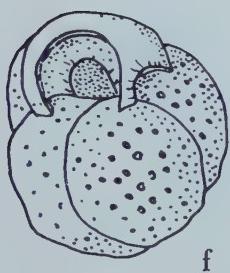
c



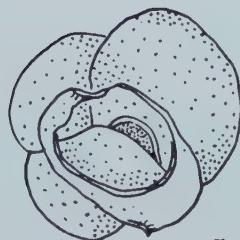
d



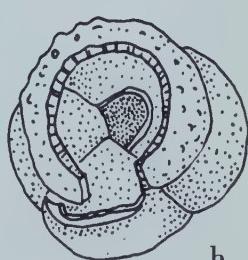
e



f

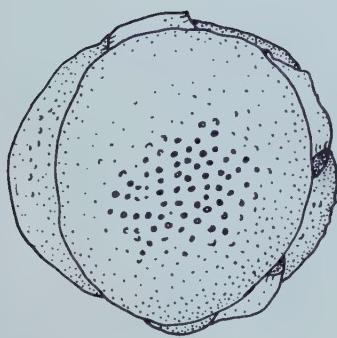


g

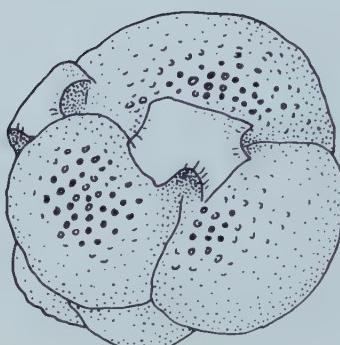


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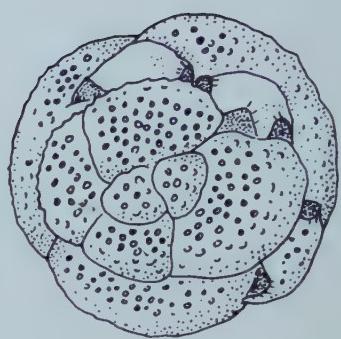
BRONNIMANN — Text Figure 2



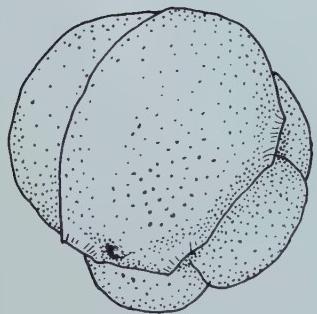
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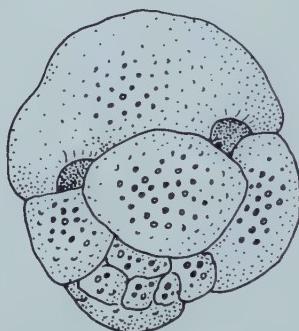
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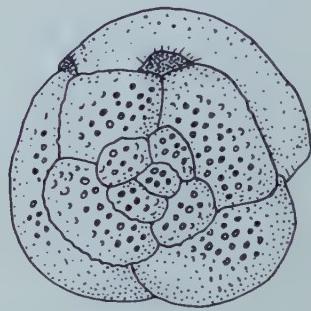
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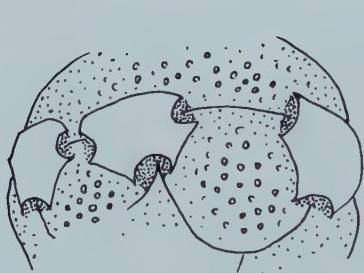
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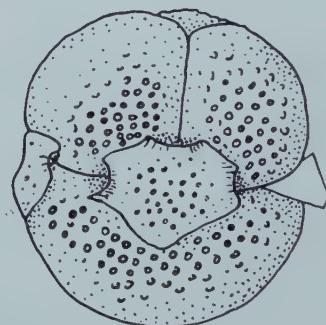
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BRONNIMANN — Text Figure 3

ognize the individual early chambers and the details of arrangement. The subglobular chambers are rapidly increasing in size and the ultimate chamber is peripherally slightly flattened. The large semicircular umbilical main aperture lies at the intersection of the three sutures of the end chambers (Figure 2, f, h). In addition, a small rounded auxiliary *Globigerinoides* aperture exists, almost opposite the main aperture, in the corner between the initial portion and the two last chambers (Figure 2, e). Due to the masking effect of adhering matrix, the small *Globigerinoides* aperture is not always visible. Occasionally, and only discernible under higher magnification, a minute covering plate across the *Globigerinoides* aperture can be seen. In grown up individuals, this plate develops into a low chamberlike growth.

All the investigated specimens are characterized by low to slightly inflated supplementary chamberlike growths. The following types of arrangement can be distinguished:

- a) Across umbilicus, covering the main aperture with 3 small semicircular openings situated at the sutures. Present in all individuals (Figures 1, 2).
- b) Across umbilicus as described above, and additional similarly structured growth issuing from the *Globigerinoides* aperture (Figure 1, a, b, c). The normal adult test shows this dual growth across umbilicus and over the *Globigerinoides* aperture. It is the predominant type of arrangement.
- c) Two chamberlike growths as described in b. The one over the umbilicus is spreading along the sutures forming 3 small, low "chamberlets," separated from the main growth by straight incisions. Each of the new "chamberlets" carries three small semicircular openings (Figure 2, b). This type is only rarely encountered.

The aperture of the adult *Globigerinoides* is multiple and in the typical case with maximum 6 small semicircular openings. In individuals with complex growths as described above, the maximum number of openings is 12. The openings have minute liplike borders.

The walls of the preceding *Globigerinoides* chambers are thicker and the pores coarser than those of the supplementary "chambers," which occasionally are transparent.

The proportion of left and right hand coiling specimens is about 2:1 (19 specimens counted). The species has been encountered in only one sample. The specimens are common and well preserved. The species

is named after the district of Moruga, South Trinidad.

Dimensions.—The maximum diameter of the test, including the chamberlike growth, was measured in 10 individuals. It varies from 220 μ to 315 μ .

Genus *Globigerinatheka* Brönnimann, n. gen.

Genotype.—*Globigerinatheka barri* n. sp., Mount Moriah formation, Upper Eocene, Trinidad, B. W. I.

Diagnosis.—Test almost spherical, comprising a trochoidal *Globigerina*, 4 chambered in its last stage, and a composite supplementary chamberlike growth on the umbilical side: consisting of a single, large, inflated, primary "chamber" across the umbilicus and of 3 small only slightly inflated secondary "chambers." Aperture of the *Globigerina* stage prior to the formation of the supplementary growth not known, probably single, large arcuate aperture characteristic for this type of *Globigerina*. Late ontogenetic aperture multiple, with maximum 9 small semicircular openings in the secondary "chambers."

Remarks.—*Globigerinatheka* is monotypic, and can be distinguished from related genera by the *Globigerina* test formed prior to the umbilical supplementary growths, which is composite in structure.

Occurrence.—Upper Eocene, Trinidad, B. W. I.

Globigerinatheka barri Brönnimann, n. sp.

Text figure 3

Holotype.—*Globigerinatheka barri* Brönnimann, T. L. L. Cat. Nos. 158007, 158028-29, Text figure 3, a, b, c, 75 \times . Mount Moriah formation, Upper Eocene, Trinidad, B. W. I. Deposited in the Cushman Collection, U. S. National Museum, Washington, U. S. A.

Description.—The test is almost globular (Figure 3) and consists of a *Globigerina* and a supplementary chamberlike growth. About 10 *Globigerina* chambers are arranged in a trochoidal spiral of 2 whorls (Figure 3, f). The end stage of the *Globigerina*, preceding the supplementary growths, is 4 chambered (Figure 3, d, f). The subglobular chambers increase rapidly in size as added. Owing to the filling of the chambers with calcite, it was not possible to investigate the apertures of the *Globigerina* stage, but in analogy to typical *Globigerinas*, it can be assumed that the apertures are single, large, arcuate openings. The supplementary chamberlike growth consists of a single, large and inflated primary "chamber" across the umbilicus of the *Globigerina* stage (Figure 3, d, e, f) and 3 small

EXPLANATION OF TEXT FIGURE 3

TEXT FIGS.

- 3 a-h *Globigerinatheka barri* Brönnimann, Mount Moriah formation, Upper Eocene, Trinidad, B. W. I. T. L. L. Cat. Nos. 158007, 158028-29. All appr. 75 \times . a, b, c, Holotype, with primary growth and 3 small secondary "chambers," each with 3 semicircular openings. a, shows the specimen from the umbilical side. c, from the initial side. d, e, f, the same specimen, with umbilical growth only. Three openings at the sutural grooves. g, h, show clearly the smaller secondary supplementary "chambers" (on the right hand side of specimen h a small crystal).

LIST OF LITERATURE

and rather flattened secondary "chambers." The latter are forthcoming from the 3 openings of the primary "chamber" (Figure 3, a, c, g). The aperture of the adult is multiple. The primary "chamber" of the supplementary growth has 3 semicircular openings at the intersections of the sutures between the 3 last formed *Globigerina* chambers and the primary "chamber" (Figure 3, e). The ontogenetic end stage shows 9 small semicircular openings situated at the sutural grooves, 3 of each per secondary chamberlike growth (Figure 3, g). The openings appear to have minute liplike borders.

Supplementary growth and *Globigerina* chambers can be easily separated by the smoother surface, thinner wall, and finer pores of the supplementary "chambers."

The direction of coiling was determined in 9 well preserved specimens, which all coil dextrally.

The species which is named after K. W. Barr for his contributions to the Geology of Trinidad has been encountered in numerous samples, but is only rarely well preserved.

Dimensions.—The maximum diameter of the test, including the supplementary growth, measured in 2 individuals, is 345 μ and 365 μ .

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54. TWO NEW SPECIES OF LEPIDOCYCLINA FROM CAPE RANGE, NORTHWESTERN AUSTRALIA¹

IRENE CRESPIN
Canberra, Australia

In 1924, the late American geologist, F. G. Clapp, collected samples of a cream, chalky, foraminiferal limestone from a locality in a deep gorge on the "east flank of Cape Range, south from North West Cape and 25 miles N. W. of Exmouth Gulf Station Homestead" (Clapp, 1925). This locality has been recognised as Badjirrajirra Creek. The limestone was examined by Chapman (1927) who recorded a large species of *Lepidocyclina* which he referred to *Lepidocyclina* (*Eulepidina*) *dilatata* (Michelotti). Since that date, other geologists have collected similar chalky limestones containing large *Lepidocyclina* from this locality which have always been determined as the species originally recorded by Chapman (Crespin, 1948, 1950).

During recent detailed geological investigations in the Cape Range area by geologists from the Bureau of Mineral Resources, Geology and Geophysics, further material was collected from Badjirrajirra Creek. The writer visited the area during June 1950 and many further excellently preserved tests were found, includ-

ing a microspheric form with a diameter of 65 mm. All specimens had peripheries of wafer-like thinness.

Many horizontal sections of individuals have been cut and examined but the wafer-like thinness of the periphery has made it necessary to study the characters of vertical sections from thin sections of the limestone. It was shown that the specimens were characterised not only by the wafer-like thinness of the periphery but also that they belonged to the group of "stratified lepidocyclina" referred to by Tan (1935) who remarked that "as yet they (stratified lepidocyclinae) are only known to occur later than Eulepidina." Consequently the discovery of *Eulepidina* with this character is of considerable interest.

Two new species of *Eulepidina* are present in this chalky limestone from Badjirrajirra Creek and both the microspheric and megalospheric generations are represented. The chalky limestone in which the larger species, *L. (E.) badjirraensis*, occurs is composed almost entirely of flat-lying megalospheric and microspheric tests and is only two feet thick. The smaller species, *L. (E.) manduensis*, occurs in white chalky limestone approximately 80 feet stratigraphically above

1. Published with permission of the Director of the Bureau of Mineral Resources, Geology and Geophysics.

the bed containing the larger species. The microspheric generation of the smaller species has approximately the same diameter as the megalospheric form of the larger species.

Eulepidina is typical of "e" stage (Miocene) in Indo-Pacific Tertiary stratigraphy and is probably the equivalent of the Aquitanian of Europe. Beds of this age are the oldest exposed in the Cape Range Structure.

The formation in which these species are found has recently been termed the Mandu Limestone. It is 265 feet thick at the type locality and consists of cream to white chalky limestone with occasional flints at the base. The structure and micropalaeontology of the Cape Range will shortly be published as a Bulletin of the Bureau of Mineral Resources, Geology and Geophysics.

All types of these two new species are housed in the Commonwealth Palaeontological Collection in Canberra. The excellent photographs were taken by H. S. Edgell of the Bureau.

DESCRIPTION OF SPECIES

Family ORBITOIDIDAE Schubert, 1920

Genus *Lepidocyclina* Gümbel, 1870

Subgenus *Eulepidina* H. Douville, 1911

Lepidocyclina (Eulepidina) badjirraensis sp. nov.

Plate 6, figures 1, 2, 5; Plate 7, figures 1, 2, 4;

Plate 8, figures 1-5

Lepidocyclina (Eulepidina) dilatata CHAPMAN (non Michelotti), 1927, p. 144, pl. 13, figs. 1, 2.

Holotype. Form A.—External characters. Test large, discoidal, wafer-like in thickness, flat except for a small central umbo. Periphery very gently undulating; concentric annulae faintly visible on test, extending from umbo outwards towards the periphery. Surface of test almost smooth and lateral chambers rarely present. Surface near umbo covered with small papillae representing the ends of vertical pillars. Median chambers visible on surface near periphery, showing the characteristic squarely hexagonal-shaped chambers.

Diameter of megalospheric form, 25 mm.; greatest thickness at umbo, 1 mm.; thickness at periphery, 0.5 mm., this thickness extending almost from the vicinity of the umbo to the periphery; diameter of umbo approximately 2 mm.

Horizontal section. Embryonic apparatus large and characteristically eulepidine. It consists of two chambers, the protoconch which is almost completely embraced by a second chamber, the deutoerconch. The protoconch is large, with a horizontal diameter of 0.9 mm. It is separated from the deutoerconch which has a diameter of 1.3 mm., by a thin wall which is irregularly heart-shaped. Protoconch is attached to deutoerconch by two short stolons. A thick wall encloses the embryonic chambers. This outer wall is encircled by numerous peri-embryonic equatorial chambers and

where visible, are so crowded that the walls touch one another. The median chambers which surround the peri-embryonic chambers are squarely hexagonal and the walls thick. This shape persists until approaching the periphery where they tend to become more regularly hexagonal. A complete study of the arrangement of the median chambers and the stolon system is not possible because of undulations and the mode of preservation of the test.

Vertical section.—A section of the test in this direction illustrated its wafer-like thinness and the stratified character of the arrangement of the thickened walls of the lateral chambers. The greatest thickness of the test is .75 mm. The embryonic apparatus is large and elongate. The greatest length in the horizontal direction is 1.2 mm. and the greatest thickness, 0.2 mm; this thickness is almost uniform for the whole length of the embryonic apparatus. The characteristic thick wall surrounding the embryonic apparatus shown in horizontal section, is equally well illustrated in the vertical direction. Four rows of thin angular-shaped lateral chambers are present on either side of the median section in the central portion of the test and these are only present for a distance of 2 mm. in that area. From this point, the number of rows of lateral chambers is quickly reduced to one which in turn extends for the remaining length of the median section. These lateral chambers are divided by very thick walls, and the thickness of 0.05 mm. is uniform for each layer throughout. The chambers in the median line gradually increase in size from either side of the embryonic apparatus outwards to the periphery.

Form B.—External characters. Test of microspheric form approximately three times as large as the megalospheric form, discoidal, flat, and except for central umbo, is wafer-like in thickness and has a slightly undulating periphery. Umbo is slightly larger than in the megalospheric form and it is surrounded by faintly visible concentric annuli.

Diameter of test, 65 mm.; thickness at umbo, approximately 2 mm.; thickness at periphery, 0.5 mm.; diameter of umbo, 5 mm.

Horizontal section.—Because of the large size of the test, its thinness and the gently undulating periphery, it has been very difficult to secure satisfactory horizontal sections. The initial chamber is minute; the embryonic portion is comprised of approximately one and a half whorls but the number of chambers comprising the embryonic apparatus cannot be determined. The chambers surrounding the embryonic apparatus are irregular in shape; these are followed by four whorls composed of lozenge shaped chambers. These chambers are followed by several whorls of arcuate-shaped chambers which, in turn, are surrounded by squarely hexagonal-shaped chambers and as the chambers pass outward to the periphery, they become spatulate and elongate-spatulate in shape. The wall of the chambers

are thick and the thickness increases towards the periphery.

Vertical section.—The description is based on a section of a test in a thin section of the limestone. It measures 55 mm. in length and has a thickness of 1.6 mm. in the central portion. Ten layers of angular-shaped lateral chambers are present on either side of the median section in the central portion, these gradually decreasing in number towards the periphery. Each layer of lateral chambers are separated by a thick wall, but not so thick as in the megalospheric form. Chambers in the median line are small in the central part of the test, measuring about 0.05 mm. in height, but increase rapidly in size and height towards the periphery where they are 3.5 mm. in height.

Occurrence.—In cream, chalky limestone, 97 feet below the top of the Mandu Limestone, in Badjirrajirra Creek, 4 miles above mouth, on east flank of Cape Range about 11 miles north of Learmonth on Exmouth Gulf and 25 miles south of North West Cape, Western Australia. Registered Numbers. Holotype, Form A, No. 729; Form B, No. 730.

Observations.—The microspheric form of this handsome species of *Eulepidina* is amongst the largest to be described from the Indo-Pacific region or elsewhere. *L. (E.) dilatata* var. *tidoenganensis* (Van der Vlerk, 1925) measures from 40 mm. to 70 mm. in diameter, but the external and internal characters of that form are quite distinct from *L. (E.) badjirraensis*. The megalospheric form of this new species is common and the diameter of the tests vary from 25 mm. to 30 mm. The species has been previously recorded by Chapman (1927) and Crespin (1948, 1950) as *L. (E.) dilatata* but there is little doubt that the wafer-like thinness of the test, the squarely hexagonal-shaped median chambers and the stratified character of thickened walls between the lateral chambers in both generations distinguish *L. (E.) badjirraensis* from that species and from all other described eulepidines. Dr. Van der Vlerk has kindly examined photographs of sections of this form and supports the erection of this new species from North West Australia.

Associated with *L. (E.) badjirraensis* are a few tests of the second new species, *L. (E.) manduensis*, described herein, *Cycloclypeus eidae* Tan (forms A and B), *Operculina victoriensis* Chapman and Parr (forms A and B) and numerous small foraminifera described from Miocene deposits in Java and Sumatra (Le Roy, 1944) and in southeastern Australia (Chapman, Parr and Collins, 1934; Howchin and Parr, 1938).

Lepidocyclina (Eulepidina) manduensis sp. nov.

Plate 6, figures 3, 4; Plate 7, figures 3, 5, 6;

Plate 8, figures 6, 7

Holotype. Form A.—External characters. Test incomplete, moderately large, discoidal with undulating

periphery. Central umbo from which surface of test slopes gently towards periphery. Periphery wafer-like in thinness. Surface of test covered with small papillae.

Diameter of test approximately 12 mm.; thickness at umbo, 2 mm.; thickness of periphery, 0.5 mm.

Horizontal section.—Embryonic apparatus characteristically eulepidine, consisting of two chambers, the subspherical protoconch and a large embracing deutoconch. Protoconch irregularly heart shaped with a diameter of 0.38 mm. Deutoconch almost embraces protoconch with a diameter of 0.8 mm. and is separated from it by a thin wall. Embryonic apparatus is enclosed by a moderately thick wall but not as thick as in *L. (E.) badjirraensis*. Deutoconch is connected with protoconch by two short stolons. The periembryonic chambers surrounding the wall of the embryonic apparatus are represented by a row of numerous auxiliary chambers (primary auxiliary) and these in turn are surrounded by three rows of interauxiliary chambers which are broadly spatulate. As these chambers pass outward to the periphery they become spatulate and elongate-spatulate in shape. The walls of the chambers are thick and as in *L. (E.) badjirraensis*, the preservation of the shell does not permit observation of the stolon system.

Vertical section.—Because of the thinness of the test of this species, it has been necessary to study individuals shown in thin sections of the limestone.

Average length of test, 12 mm.; greatest thickness in centre of test, 1.1 mm. Embryonic apparatus is elongate and is divided into three chambers, with large central one, and surrounded by thin wall. Length of embryonic apparatus, 0.5 mm. and greatest thickness 0.3 mm. Six layers of thin angular lateral chambers are present on either side of median line in central portion layers gradually decreasing in number towards the periphery. The stratified character of the species is shown by the very thick walls which divide the lateral chambers. The thickness of the wall is 0.05 mm. and is uniform for each layer.

Form B.—External characters. Test of microspheric form, flat discoidal with central umbo and periphery undulating and of wafer-like thinness. Surface finely papillate.

Diameter of test, 21 mm.; thickness at umbo, 4 mm.; thickness at periphery, 0.5 mm.

Horizontal section.—Section of test almost complete. Initial chamber minute; embryonic portion is composed of approximately one and a half whorls but none of the chambers comprising the embryonic apparatus can be determined. Chambers immediately surrounding embryonic apparatus irregular in shape. Then follows several rows of squarely hexagonal shaped chambers, which in turn are followed by elongate spatulate chambers towards the periphery. The thick wall of the chambers does not permit the study of the stolon system.

Vertical Section.—As with the megalospheric form the structure of the test in vertical section has to be studied from thin sections of the limestone. Section not completely central. Test approximately 15 mm. in length with greatest thickness of 3 mm. Ten layers of angular shaped lateral chambers on each side of the median line, these gradually decreasing in number towards the periphery. Each layer of chambers separated by thick wall which is not quite as thick as in the megalospheric form. Median chambers small in central part and increase gradually in size towards the periphery where they are 0.2 mm. in height.

Occurrence.—In white, chalky limestone, 17 feet below top of Mandu Limestone, in Badjirraijira Creek, 4 miles above mouth, on east flank of Cape Range about 11 miles north of Learmonth on Exmouth Gulf and 25 miles south of North West Cape, Western Australia. Registered Numbers. Holotype, Form A, No. 731; Form B, No. 732.

Observations.—*L. (E.) manduensis* is smaller in size than *L. (E.) badjirraensis*; the microspheric form of the species is approximately of the same size as the megalospheric form of *L. (E.) badjirraensis*. It has the same wafer-like thin periphery. The wall surrounding the embryonic apparatus is thinner than in the larger species but the thick wall of the lateral chambers is similar giving *L. (E.) manduensis* the same stratified character as *L. (E.) badjirraensis*. Microspheric tests are very common in a friable limestone at the type locality and many of them have strong undulating peripheries.

L. (E.) manduensis occurs in abundance near the top of the Mandu Limestone at the type locality. The large tests of *L. (E.) badjirraensis* rarely occur in this bed but species of *Nephrolepidina* such as *L. (N.) borneensis* Provale and *L. (N.) verbeekii* (Newton and Holland) are present. *Operculina* and *Cycloclypeus* are common as well as numerous small foraminifera similar to those associated with *L. (E.) badjirraensis*.

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55. REINSTATEMENT OF OSANGULARIA BROTZEN, 1940,
FOR PARRELLA FINLAY, 1939,
(NON GINSBURG, 1938)

HANS E. THALMANN and JOSEPH J. GRAHAM
Stanford University

On August 18, 1950, the late H. J. Finlay (Wellington, New Zealand) was notified by letter that his genus *Parrella* erected in 1939 (Finlay, p. 523) with *Anomalina bengalensis* Schwager, 1866 as genotype, was pre-

occupied by *Parrella* Ginsburg a year before (Ginsburg, 1938, p. 116) for a new genus among the fishes. Shortly before his untimely death Mr. Finlay (letter of February 13, 1951) wrote us, as follows:

"It is unfortunate that my genus **Parrella** is preoccupied. It will not need re-nomination, for there is already a name available for the **cultus-bengalensis** lineage. In 1940, Brotzen introduced the new genus name **Osangularia** for this group with **O. lens** n. sp. as genotype, and quoting as congeneric **cordieriana** d'Orb., **cultus** of Plummer (non Parker and Jones), **texana** CUSH., **glabrata** CUSH., and **navarroana** CUSH. His species occurred in the Upper Cretaceous and Older Tertiary, where this genus is common. He later published a work dealing with all the rotalioid genera much more fully than I did, so he deserves more credit. In a still later publication (1944) Brotzen gives good figures of **lens** and admits that **Osangularia** is a synonym of **Parrella**, as indeed I think his figures and description clearly show. Therefore, and I think you will agree with me, **Parrella** should simply be suppressed in favour of **Osangularia** Brotzen, 1940, and no re-naming is needed. I should be glad if you would publish a note to this effect."

Since *Parrella* Finlay 1939 is unquestionably a primary homonym of *Parrella* Ginsburg 1938, and in order not to burden the nomenclature of the Foraminifera with *nomen novum*, we fully concur with our late friend and indefatigable worker, and herewith propose that *Osangularia* Brotzen, 1940 be reinstated as an available generic name:

Genus **Osangularia** Brotzen, 1940

Synonymy.—*Parrella* Finlay, 1939, Roy. Soc. New Zealand, Trans., vol. 68, p. 523 (Genotype: *Anomalinella bengalensis* Schwager, 1866, Novara-Exped., Geol. Theil, vol. 2, p. 259, pl. 7, fig. 111) non: *Parrella* Ginsburg, 1938, Allan Hancock Pacific Exped., Publ. vol. 2, p. 116, *Pisces*.

Genotype of *Osangularia* Brotzen—*Osangularia lens* Brotzen, 1940, Sverig. geol. Unders., Ser. C, No. 435, Arsb. 34, No. 5, p. 30, text fig. 8, Nos. 1 a-c, Upper Cretaceous, Sweden.

Family.—Rotaliidae.

Geologic range of genus.—Cretaceous to Recent, more commonly in Upper Cretaceous and Paleocene.

Further reference.—*Osangularia lens* Brotzen, Sverig. geol. Unders., Ser. C, No. 465, Arsb. 38, No. 7, (1944), Stockholm 1945, p. 56, pl. 2, fig. 7; text fig. 10, from Danian of Trelleborg and Malmö, Sweden.

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GINSBURG, 1938, Allan Hancock Pacific Exped. Publ., vol. 2, p. 116.

RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the foraminifera that have come to hand.

ASANO, KIYOSHI. Illustrated Catalogue of Japanese Tertiary Smaller Foraminifera (compiled and edited by Leo. W. Stach).—Tokyo, Japan. Part 9: Ophthalmidiidae; Part 10: Lituolidae; Part 11: Trochamminidae; Part 12: Chilostomellidae; Part 13: Anomalimidae; Oct. 15, 1951, pp. 1-19, text figs. 1-8; 1-29; 1-6; 1-15; 1-52.—Continuing the series, 51 species, 8 new, are described and illustrated, and a new genus **Disc-anomalina** (genotype **D. japonica**, n. sp.) erected.

Part 14: Rotaliidae, Oct. 31, 1951, pp. 1-21, text figs. 1-155.—Sixty-one species and varieties, 15 new, are described and illustrated.

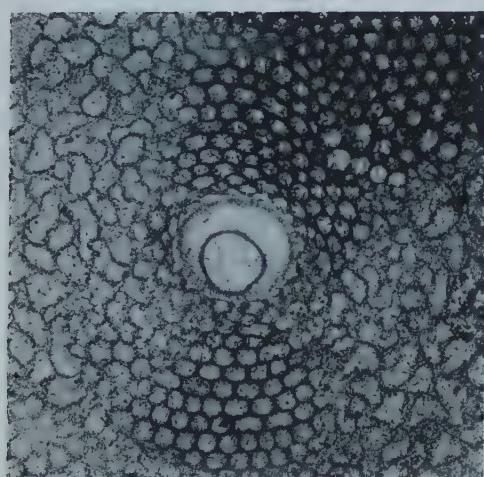
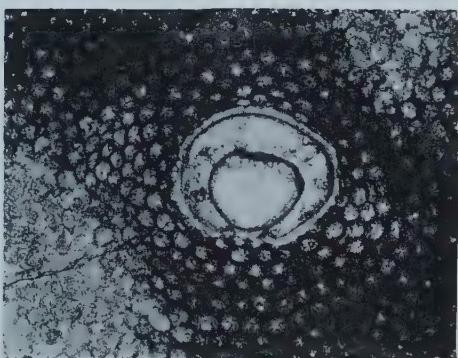
BRONNIMANN, P. Internal structure of **Cyclammina cancellata**.—Journ. Pal., vol. 25, No. 6, Nov. 1951, pp. 756-761, text figs. 1-13.—The labyrinthic structure consists of three types of alveoles successively appearing in ontogenetic development. Evolution of the genus from **Haplophragmoides** is indicated by the structure and by ontogenetic changes in the aperture.

BUTCHER, W. S. Foraminifera, Coronado Bank and vicinity, California.—Univ. Calif., Scripps Instit. Oceanography, ref. 51-21, Submarine Geol. Rept. No. 19 from the Marine Foraminifera Laboratory, Sept. 15, 1951, mimeographed, pp. i-iii, 1-9, text figs. 1-6.—The top of Coronado Bank has a high total population, about 50% of the sediment, apparently from lack of clastic sediments. Several depth boundaries are rec-

EXPLANATION OF PLATE 7

FIGS.

	PAGE
1. <i>L. (E.) badjirraensis</i> Crespin, n. sp. Megalospheric form. Horizontal section showing eulepindine embryonic apparatus, periembryonic chambers attached to outer wall, ad-auxiliary chambers and squarely-hexagonal-shaped median chambers. $\times 22$.	29
2. <i>L. (E.) badjirraensis</i> Crespin, n. sp. Megalospheric form. Horizontal section showing the squarely-hexagonal median chambers passing onwards to periphery; also undulating character of test. $\times 8$.	29
3. <i>L. (E.) manduensis</i> Crespin, n. sp. Megalospheric form. Horizontal section showing typical eulepindine embryonic apparatus surrounded by a thinner wall than species in Fig. 1. $\times 32$.	30
4. <i>L. (E.) badjirraensis</i> Crespin, n. sp. Microspheric form. Horizontal section showing characteristic median chambers and undulating test. $\times 10$.	29
5. <i>L. (E.) manduensis</i> Crespin, n. sp. Megalospheric form. Section showing almost circular shape of protoconchal chamber. $\times 31$.	30
6. <i>L. (E.) manduensis</i> Crespin, n. sp. Microspheric form. Section showing characteristic squarely-hexagonal median chambers and undulating test. $\times 4$.	30



Crespin: *Lepidocyclina* from Australia



Crespin: *Lepidocyclusina* from Australia

ognized, the boundaries having large range in depth. Depth ranges are shown for many species, and percentage composition of samples shown in tables.

de CIZANCOURT, MME. M. Grands Foraminifères du Paléocène, de l'Éocène inférieur et de l'Éocène moyen du Venezuela.—Mem. Soc. Géol. France, n. ser., vol. 30, fasc. 1-2, Mem. No. 64, pp. 1-68, pls. 1-6, text figs. 1-19 (mostly maps), table.—The distribution of 49 species is shown in a table. Eighteen species and varieties, 7 new, are described. Many species are figured in section.

COLOM, GUILLERMO. Globigerina "ratio."—Su distribución y complejidad en los mares Tercarios alrededor de la Mesieta Castellana.—P. Inst. Biol. Apl., vol. 9, 1951, pp. 63-82, pls. 1-6, text figs. 1-7.—A study of the changing marine sedimentary conditions in the Tertiary of Spain as indicated by the appearance, abundance and dying out of globigerinid species. Results are graphically represented and numerous species are illustrated.

GOUDKOFF, PAUL P., and NEREIDA C. MENDOZA. Range chart showing known stratigraphic occurrence of Foraminifera in Eocene of California.—(Mimeo-graphed; not published in a journal), 25 pp.

ISHIWADA, YASUFUMI. Foraminiferal death assemblages from the mouth of Toyama Bay (Studies on Recent Marine Sediments No. 1).—Bull. Geol. Survey Japan, vol. 1, No. 4, November 1950, pp. 182-194, pl., 1 map, 13 graphs, 3 tables.—Study based on 8 samples. Generic composition is graphically represented for each station and they are grouped into 4 different assemblages. Seventy-nine species are listed and their occurrence and abundance shown. A few of these are described and illustrated. Two are new.

LOEBLICH, A. R., and HELEN TAPPAN, in FRANK E. LOZO. Stratigraphic notes on the Maness (Comanche Cretaceous) shale.—The Woodbine and Adjacent Strata, Fondren Sci. Ser., No. 4, 1951, pp. 82-89, pl. 2.—Notes and illustrations of 8 species, 2 of which are described as new.

MURAOUR, P. Sur une coupe levée dans la région d'Ouled Ahmed ben Aïssa (Algérie, Carte Dellys-Tizi Ouzou).—C. R. S. Soc. Géol. France, No. 11, séance du 4 juin 1951, pp. 183-185.—Foraminifera are listed.

NATLAND, M. L., and PH. H. KUENEN. Sedimentary history of the Ventura Basin, California, and the action of turbidity currents.—Soc. Econ. Pal. and Min. Spec. Publ. No. 2, Nov. 1951, pp. 76-107, text figs. 1-25.—Foraminiferal evidence indicates a depth of sev-

eral thousand feet in the Ventura Basin during upper Tertiary. Redeposition of Foraminifera indicates progressive uplifting of one part and sagging of another part of the basin.

PHLEGER, FRED B. Displaced Foraminifera Faunas.—Soc. Econ. Pal. and Min. Spec. Publ. No. 2, Nov. 1951, pp. 66-75, text figs. 1-7.—Shallow-water species of benthonic Foraminifera found in deep-water sands are evidence of displacement of these sands down the slope. Such displaced faunas occurring in cores indicate a complex history for the area. Examples from the San Diego Trough and Sigsbee Deep are given.

POST, RITA J. Foraminifera of the South Texas Coast.—Publ. Instit. Marine Sci., vol. 2, No. 1, Sept. 1951, pp. 165-176, pl. 1, table 1.—Distribution and abundance of about 30 species found in the contrasting facies of the coastal area are plotted. Most of the species are illustrated.

POZARYSKI, W. Les Foraminifères éémiens de Tchernowcy.—Ann. Soc. Geol. Pologne, vol. 20, fasc. 3, Ann. 1950 (1951), pp. 311, 312.—Nine species are listed, indicating a temperate climate.

RITSEMA, L. Description de quelques Alvéolines de Timor: résultat d'une élaboration de la méthode des courbes d'indice de Reichel.—Kon. Nederl. Akad. Wetenschappen, Proc., ser. B, vol. 54, No. 2, 1951, pp. 174-182, text figs. 1-4.—Four already known species are described and illustrated and geographically represented.

TAPPAN, HELEN. Foraminifera from the Arctic slope of Alaska. General introduction and Part 1, Triassic Foraminifera.—U. S. Geol. Survey Prof. Paper 236-A, Dec. 1951, pp. 1-20, pls. 1-5, text figs. 1, 2 (maps).—This first Triassic fauna discovered in the Western Hemisphere includes 26 species, all new. One new genus erected: *Sagoplecta* (genotype *S. goniata*, n. sp.) in the family Polymorphinidae. The introduction describes ecologic conditions during Triassic, Jurassic, Cretaceous, and Pleistocene times, as indicated by biostratigraphy.

VIALLI, VITTORIO. I Foraminiferi Luteziano-Priaboniani del Monte Orobio (Adda de Paderno).—Atti Soc. Ital. Sci. Nat. Museo Civico Stor. Nat. Milano, vol. 90, fasc. II-III, 1951, pp. 97-168, pls. 5-7.—Fifty-seven species and varieties of larger Foraminifera (of which 42 belong in the Camerinidae), and eleven species and varieties of smaller Foraminifera (of which one *Discorbis* is new) are recorded from three stratigraphic levels in the Eocene series, and most of them are illustrated. Ranges of the species are shown in a table.

EXPLANATION OF PLATE 8

FIGS.	PAGE
1. <i>L. (E.) badjirraensis</i> Crespin, n. sp. Megalospheric form. Showing thickened walls between lateral chambers. $\times 14$.	29
2. <i>L. (E.) badjirraensis</i> Crespin, n. sp. Showing enlarged central portion of Fig. 1. $\times 28$.	29
3. <i>L. (E.) badjirraensis</i> Crespin, n. sp. Megalospheric form. Vertical section showing large elongated embryonic apparatus and characteristic thin tests. $\times 6$.	29
4. <i>L. (E.) badjirraensis</i> Crespin, n. sp. Enlarged view of central portion of Fig. 3, showing thick wall of embryonic apparatus.	29
5. <i>L. (E.) badjirraensis</i> Crespin, n. sp. Microspheric form. Vertical section near periphery, showing thinness of test and undulating character. $\times 3.5$.	29
6. <i>L. (E.) manduensis</i> Crespin, n. sp. Megalospheric form. Vertical section. $\times 20$.	30
7. <i>L. (E.) manduensis</i> Crespin, n. sp. Megalospheric form. Vertical section showing the embryonic apparatus divided into three chambers. $\times 24$.	30

WEYNSCHENK, ROBERT. Two new Foraminifera from the Dogger and Upper Triassic of the Sonnwend Mountains of Tyrol.—Journ. Pal., vol. 25, No. 6, November 1951, pp. 793-795, pl. 112, text figs. 1-3.—

Labyrinthina mirabilis n. gen., n. sp. and a Jurassic form of the Recent species, **Recurvoidea trochamminiforme**.

RUTH TODD

CORRECTIONS

In Art. No. 38 by P. Bronnimann, this Contributions, vol. II, pt. 4, 1951, the following corrections should be made:

p. 134: second last line of first paragraph: delete "lower."

p. 136: last line of chapter on Facies Distribution read "autochthonous" instead of autochitinous.

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